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EDUCATION IN WEST AFRICA

MR. WALTER ELLIOT has recently said there has been lack of public interest in Great Britain in the two new University Colleges in West Africa established since the end of the War. A number of scientific men are aware of the demands which the building up of the teaching staffs of fifty in the Gold Coast and of sixty-seven in Nigeria have made on the British universities, and of the difficulties which are still being encountered in finding staff for the research institutes contemplated in West Africa sometimes in proximity to, if not in association with, the new University Colleges. Others, through the reports of the Colonial Research Council, the Colonial Products Research Council and the Colonial Medical Research Committee, are aware of the opportunities for scientific work which such areas present; and the educational problems of these new institutions have been well indicated in the last annual report on the Colonial Territories (cf. *Nature*, **166**, 201; 1950).

The report* of Dr. G. B. Jeffery to the Secretary of State for the Colonies on his visit to West Africa, December 1949 to March 1950, to study and advise upon a proposal to institute a West African Schools Examination Council not only makes those problems even clearer but also shows how closely related they are to those of Great Britain, and how much the educational institutions of West Africa depend on us for assistance in reaching an effective solution. Dr. Jeffery goes straight to first principles, considering first the functions of examinations in a developing educational system before attempting to forecast the examinations likely to be needed. His analysis of the three types of examination which he distinguishes is not without interest in relation to changes taking place in our own system, where the external examination has become the restraint upon the activity of the teacher on which Dr. Jeffery remarks.

In this connexion it is important to note the characteristics of the evolution of the school examination in Britain to which Dr. Jeffery directs attention, and particularly the steady growth of co-operation between school and university teachers in the conduct of the examinations and more especially in framing syllabuses. This co-operation, he points out, has ensured that a certain number of teachers in the universities understand the educational problems which arise in the schools, and has gone far to secure the realization of the ideal of a school examination—that it should follow and not control the development of good teaching in the schools.

The second characteristic is the progressive passing of the control of the school curriculum from the examining bodies to the schools, and Dr. Jeffery directs attention to the special relationship which is implied between a university examining body and the teachers in the schools taking its examinations. The teachers are in a position of trust towards the examining body, which relies upon them for assistance in the progressive adaptation of the examinations to

* Gold Coast Colony. Report to the Secretary of State for the Colonies by Dr. G. B. Jeffery on a Visit to West Africa, December 1949 to March 1950. Pp. 16. (Accra: Government Printing Department; London: Crown Agents for the Colonies, 1950.) 2s.

the work of the schools and the educational needs of the pupils, and especially to avoid in their schools the harmful effects which can so easily follow from the misuse of even a good examination. For these reasons a university examining body is rightly jealous of the quality and reputation of the schools which are admitted to a school examination conducted by it.

The third type of examination is the 'competitive examination', such as is used for the purposes of appointments in government service or the award of scholarships. These examinations differ from the others in both purpose and technique, and Dr. Jeffery has observed ill-effects in West Africa from confusing these distinctive functions and attempting to make one examination serve both as a competitive examination and to establish settled educational standards. He points out that it would only add to the confusion if any competitive examination which might be established was capable of being used indirectly as a qualifying examination.

The determination of the right place of examinations of these several kinds is a matter of great importance in the development of education in West Africa, and Dr. Jeffery recognizes that, despite all efforts and intentions to the contrary, the examinations commonly taken by school pupils and young persons in any country profoundly influence educational practice and the public repute of teachers and schools. But while African views on education, even those held by some good African teachers, are apt to appear to the outside observer to be utilitarian or even mercenary, he remarks that a school would fail if it did not fit its boys to fill posts in which they can give good service to the community. It is a good and not a bad thing that many Africans are prepared to study after their day's work to attain the standard of general education represented by a matriculation examination. A deeper understanding of educational values might well lead to the conclusion that other forms of adult education would better meet the needs of some of the pupils of the matriculation classes, and that the purpose of a school should go beyond the mere obtaining of good posts for its boys to an effort to secure that the posts will be fulfilled honourably in the service of the community.

Dr. Jeffery finds some evidence that this would be admitted by African educationists, though probably the full implications are not yet appreciated. His own impression is that we have reached a critical stage in the development of education in West Africa, and therefore a critical stage in the development of African life. It is a stage at which it is all-important that high standards should be established, maintained, and accepted in every department of public and private life—in politics and public affairs, in commerce and industry, in behaviour, in scholarship, and in craftsmanship. The outstanding need of Africa to-day is that more Africans in every walk of life should do their work and carry their responsibilities superbly well according to standards of excellence which West Africans accept as their own.

Though Dr. Jeffery is concerned primarily with the establishment of good educational standards and particularly with building up a hard core of really good secondary education, his observations have a much wider bearing. It is not simply that a mistaken educational and examination system, by causing the curriculum to be excessively concerned with the study of text-books, may provide the country with too many of one type of school-leavers. A race of clerks will never be capable of grasping the opportunities which the devolution of self-government offers to them, or even of discharging all the responsibilities which self-government entails. The possibility of great achievement depends largely upon the setting up of high standards of work and behaviour; and once those standards are established, provided they can be maintained, there need be no fears as to the speed at which the transition to African responsibility can be made.

Dr. Jeffery is optimistic on the educational issue. He is convinced that the peoples of West Africa have great contributions to make to art and literature, and to the achievements of the human spirit, which cannot be evaluated in terms of money or personal status, or assessed by any examination. He is also convinced that a responsibility has devolved upon the African teachers to inculcate standards of moral integrity which are rooted in the life and thought of the people. The sincere desire in the West African territories for greater educational facilities is doubtless sometimes exploited by unscrupulous persons, and some of the forms of education which emerge are far from satisfactory. It must also be accepted as a fact of the present situation that, whatever examinations are held, the passing of these examinations will be given undue importance in the minds of the pupils and their parents. This does not lead Dr. Jeffery to conclude that examinations should be abolished or discouraged in West Africa, but rather that the questions of what examinations should be made available and the way in which they can best be adapted to educational purposes should be decided on educational grounds alone by the best available West African educational opinion and experience. The proposed West African Examinations Council should be constituted in such a way that it will be regarded as an authority on educational opinion both in West African territories and elsewhere. An important part of its responsibilities should be the education of public opinion in relation to examinations, thus meeting the challenge to promote the steady growth of a more informed educational outlook.

Dr. Jeffery concurs with the opinion of the directors of education that the Council should be a West African Council concerned with questions of examinations in all four territories. He does not think that the time is ripe for the institution of examinations conducted entirely on the authority of a West African body, chiefly because such examinations would be unlikely at this stage to achieve the desired measure of recognition in other countries. He recommends, therefore, that the Council should, from the beginning, be given the power to conduct certain examinations on its own authority, and that it should be trusted not to exercise this power prematurely. It should also be empowered to invite examining bodies in

Great Britain to conduct examinations in West Africa and to accept, in agreement with the examining bodies, administrative responsibility for the conduct of examinations, as well as to advise such examining bodies on the adaptation of their examinations to the educational needs and circumstances of West Africa, without detriment to standards. If so requested by one or more of the Governments, the Council should also be empowered to accept responsibility for the conduct of examinations for appointments or awards by Government.

The proposed Council would consist of a chairman and nine *ex-officio* and twenty-two appointed members, and would be assisted by eight local advisory committees based at Accra, Bathurst, Cape Coast, Enugu, Freetown, Ibadan, Kaduma and Kumasi. Dr. Jeffery visualizes the Council as probably responsible for five types of examination: a school certificate and higher school certificate examination restricted to candidates from approved schools; examinations for pupils in technical institutes; examinations for pupils in commercial schools; competitive examinations for appointments in Government service; and a public examination open to all candidates.

There are other observations of wider interest in the forecast of the examinations likely to be needed which leads Dr. Jeffery to this conclusion. He notes the different stage of development which secondary education in West Africa has reached compared with the United Kingdom, and the greater degree of maturity required when a student intends to enter a university at a great distance from his home and in a place where the circumstances of life and language are different from those in which he has grown up. He suggests that until the supply of graduate teachers is very much greater than at present, such teachers should be used in strengthening the work of the school up to the school certificate level rather than for higher school certificate work. He is convinced that if the West African University Colleges and Fourah Bay College are to fulfil their destiny their work must always be based fairly and squarely upon that of the West African secondary schools. Moreover, it is essential for their development that the best available African students should go to them for their undergraduate studies. It would be disastrous to the prospects of the University Colleges if there were any general acceptance of the idea that the best students proceeded to English universities and that those who are not so good went to the West African University Colleges. Dr. Jeffery suggests that the Colleges of Art, Science and Technology should in the meantime undertake the work of providing the courses or studies at higher school certificate level to enable students proceeding to universities in the United Kingdom to comply with the new entrance requirements. Very careful consideration would, however, have to be given to the danger of the Colleges being thereby deflected from their proper purposes.

There is thus much in this report that deserves to be studied by those who are not primarily educationists. There are warnings which should be noted by all who are in any way concerned with development and welfare in West Africa or indeed in the African territories as a whole. If Dr. Jeffery's report were widely read and studied, it is difficult to believe that some of the well-meaning but bizarre proposals recently advanced, such as that for the teaching of journalism in the Colonial university colleges, would ever have been made. The report also provides emphatic endorsement of the value of that intellectual 'lease-lend' between the universities of Britain and of the Commonwealth for which Dr. E. G. Malherbe, vice-chancellor of the University of Natal, pleaded in a recent issue of the *University Quarterly*. A large proportion of the teachers, and much of the tradition, of the West African University Colleges must come from Great Britain and, for a generation at least, be continually replenished from this source. Few things could contribute more to the establishment and maintenance of the high standards in every department of African life, which Dr. Jeffery rightly regards as so vital, as two-way traffic between the Dominion and Colonial universities and those of Great Britain in mature graduates as research workers, as well as lecturers, especially in subjects such as botany, anthropology, entomology, archæology, etc., where the younger countries offer virgin fields to explore. What the graduates from the younger country learn of the intellectual freedom and open-mindedness of the old countries can be a vital contribution towards not merely the establishment of educational but also of political standards and traditions.

CLASSICAL RADIOACTIVITY AND ITS SEQUENCE

The Story of Atomic Energy

By Frederick Soddy. Pp. viii + 136. (London: Nova Atlantis Publishing Co., Ltd., 1949.) 20*s*.

THE name of Frederick Soddy is familiar to all men of science as the founder, with Ernest Rutherford, of the theory of radioactive disintegration and as the discoverer of isotopy. Specialists in radioactivity will further remember a great number of brilliantly conducted experimental researches in other branches of their science; but only few of the younger generation seem to know anything about his popular books, which were distinguished by literary qualities of an order rarely to be found in the writings of the leaders of science. "The Interpretation of Radium" was published in 1909 and eagerly read by thousands; it was revised, enlarged and translated several times and finally replaced in 1932 by "The Interpretation of the Atom", which brought the story up to date; but so great are the advances made since in radioactive research that to-day this book, too, would be only of limited value even if it were still obtainable.

It is an event which will give great pleasure to all interested in the history of the discovery and utilization of atomic energy that Prof. Soddy, long retired from active research and after years of scientific silence, has devoted himself to the task of presenting once more a complete history of the main discoveries which form the basis of the science of radioactivity. "The Story of Atomic Energy" includes much of the material of the two earlier books; but the whole subject has now been re-

written from the point of view reached at the end of the Second World War when the two bombs that finished it demonstrated to the whole world the tremendous importance of atomic energy. (The author, by the way, prefers to call this energy, when released, "tomic" energy, since fission, and not indivisibility, is its secret.)

The scope of the book is very large. It deals with all the major discoveries in radioactivity, paying no less attention to the contributions by chemists than by physicists, and therefore refusing to give to this science the narrower modern title 'nuclear physics'; it does not start with Becquerel's discovery in 1896, but with the origins of chemistry in Egypt and Greece, and leads the reader through all the successive stages of the development of the atomic theory. The author bases his narrative on extensive historical studies and not infrequently disagrees with accepted standards; for example, credit is given not to John Dalton but to William Higgins for being the first to proclaim the modern atomic theory, a statement supported by detailed references to the two books of this "almost forgotten investigator". Dalton's astonishing limitations as a scientific thinker—as revealed in his notes about the constitution of gases and his stubborn fight against Gay-Lussac's results which was the consequence—seem to justify the more modest position allotted to him here. In any event, writers of chemical text-books will now have to re-examine this question.

Several chapters of the book are devoted to the explanation of physical principles, and the great part theoretical physics has played in the last phases of the liberation of atomic energy is duly emphasized. Other passages describe apparatus like the Wilson chamber, mass spectrograph, Geiger counter and cyclotron, and one regrets that the technique of reproducing the half-tone pictures does not do credit to the value of the originals. Whatever the topic may be, the personal opinion of the author is always very clearly stated.

No one could vie with Prof. Soddy in competence to write such a book. Not only is he—as he says himself in the preface—"the sole surviving participator in their origin of the discoveries and ideas, which in 1945 culminated in the destructive release of tomic energy", but he could claim with equal justification that he was among the first of the scientific leaders of our age who became interested in the social implications of their work. To-day there is widespread discussion on the responsibility towards the community of men of science and particularly experts in radioactivity; but a perusal of Prof. Soddy's non-chemical writings of no less than thirty years ago shows how strongly he felt the duty to fight for a better order of things. Only the last paragraphs of the book under review bear titles like "The Proper Use of the New Knowledge", "Science and the Community", "The Divorce of Science from Culture, Philosophy and Government", but the spirit forcefully expressed here pervades the whole book. It is not written for those who are looking for instruction in the latest discoveries connected with atomic energy—there are other books available for the study of details; but whoever seeks an understanding of all the essential steps by which the harnessing of atomic energy by mankind has been achieved, and who likes to be conducted on his tour by one who for half a century has studied these questions—always completely independent of the views current in science, politics and economics, and frequently opposed to them—will be rewarded by a coherent view over one of the most fascinating developments in the long history of human civilization, an excursion made very impressive by the range of the survey, and by the personality of the guide.

F. A. PANETH

ADVANCED TEXT-BOOKS OF ORGANIC CHEMISTRY

Lehrbuch der organischen Chemie

Von Prof. Paul Karrer. Elfte, verbesserte Auflage. Pp. xxii + 1082. (Stuttgart: Georg Thieme Verlag, 1950.) 45 D. marks.

Organic Chemistry

By Prof. Paul Karrer. Original translation by A. J. Mee. Fourth English edition, revised and enlarged in accordance with the eleventh German edition by Dr. H. V. Simon and N. G. Bisset. Pp. xxi + 983. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1950.) 57*s*. 6*d*.

A Manual of Organic Chemistry for Advanced Students

By Dr. G. Malcolm Dyson. Vol. 1: The Compounds of Carbon, Hydrogen, Oxygen and the Halogens. Pp. xiii + 984. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1950.) 63*s*. net.

THE first of these volumes, "Lehrbuch der organischen Chemie", is now in its eleventh edition and has become so much an institution among teachers and students of organic chemistry that one notes with some surprise that the first edition was published as comparatively recently as 1927. This work by Prof. Paul Karrer is pre-eminent among the text-books of descriptive organic chemistry and is so well known that the new edition and its English translation perhaps need little comment. Dr. G. M. Dyson's "Manual" is an entirely new venture, and it is characteristic of his fecundity as a chemical writer and a tribute to his courage that he should have undertaken single-handed a task of such magnitude. The volume under review is the first of three, so that it is too early to express an opinion about the scope of the whole work. As is the case with Karrer's text-book, Dyson's Vol. 1, which compares with it in length, is largely free from a theoretical treatment of the subject, although this is promised for Vol. 3.

As a comprehensive text-book for advanced students, Karrer's publication seems of a suitable length. It includes some mention of all the main groups of organic compounds, and, in general, the amount of detail is sufficient to give the student a clear picture of the chemistry of the substances discussed.

The fourth English edition of Karrer's text-book, "Organic Chemistry", corresponds very closely to the eleventh German edition. The author's preface to the fourth English edition lists some of the additions and revisions which have been made since the publication, in 1947, of the third English edition. These changes, designed to bring the book up to date, are welcome, but are of a minor character, and the fourth English edition is not substantially different from the third.

More might have been done to modernize the text of the English edition. Thus, although streptomycin is described, there is no reference to chloromycetin or other newer antibiotics. Additions to the alkaloid section might have included mention of the synthesis of sparteine and of (±)-tetrahydrodeoxycodeine. Also, the section on adrenal cortical hormones might have been brought more up to date, and the table of poisonous substances might have included the fluorophosphonates. In some parts the attitude is still that of fifteen or twenty years ago. This is exemplified by the structures assigned to aliphatic diazo compounds (p. 293) and by the footnote on p. 722. In revising the text, opportunity has been taken to improve some of the details of style which were unsatisfactory in the third edition. These attempts to give a more accurate English translation of the German text have not invariably been very successful. Thus, whereas the third edition refers to the accuracy of Kekulé's formula for benzene having been confirmed, in the fourth edition "accuracy" has been replaced by "justification". Also, the heading "Zuckerähnliche Polysaccharide" of the German edition, translated in the third English edition as "Polysaccharides resembling sugars", appears in the fourth edition, without explanation of the term, as "Oligosaccharides". There are many other minor points of criticism which could be advanced, but these do not detract from the general conclusion that these new editions of Prof. Karrer's text-book, in German and in English, fully maintain the high standard of excellence, both in content and in production, which has always characterized this work.

Dyson's work, when complete, is to be apparently about three times as big. The average honours student will certainly not have time to digest such a large text-book. I find it a little difficult to foresee what precise purpose the book will serve. Although somewhat too elaborate for a student's text-book, it cannot be regarded as sufficiently authoritative to serve as a more comprehensive treatise for the teacher and research worker. If one examines in detail sections dealing with subjects with which one is very familiar, one finds numerous instances of emphasis wrongly placed, and the facts are not always accurately recorded. The trouble is, of course, that organic chemistry has become so vast that it is beyond the capacity of a single individual to write with authority on all its specialized and intricate branches. With this reservation, Dr. Dyson's book may be warmly commended as a rich source of information not readily available elsewhere in so compact a form.

The book represents in many respects a departure from the usual conventions associated with text-books of organic chemistry. Although the chapters are systematic in regard to content, an elementary knowledge of the subject is assumed, and there is no section on organic analysis and the derivation of formulæ. There is a full description of the literature of organic chemistry, with advice and guidance on its use. In some respects this seems unnecessarily detailed, for eight pages are devoted to reproduction of the entries in "Beilstein" relating to phenylisothiocyanate. As might be expected of this author, there is an excellent chapter devoted to a discussion of nomenclature. The customary convention of dividing the subject into aliphatic, alicyclic, aromatic and heterocyclic sections is not observed. The chapter on hydrocarbons deals with all the groups of these compounds, and this same method of treatment is used in the following chapters, which describe alcohols, phenols and ethers and then aldehydes and ketones, followed by acids and esters. Separate chapters are devoted to the terpenes, the carbohydrates and polyhydric alcohols, and the vitamins, hormones and steroids.

At first sight it may seem attractive to classify together all compounds of similar function, but in fact it is impracticable to do this. The chapter on hydrocarbons is not complete, for the terpene hydrocarbons are treated in a subsequent chapter. Also, the present volume does not include, except in passing, references to compounds containing nitrogen or sulphur. Hence the second volume, which will presumably include accounts of heterocyclic compounds containing these elements, will need to deal with their derivatives containing the same functional groups which form the subjects of several chapters of the volume now under review. It is difficult to trace any real system in the classification used. A chapter concerned with substances of biochemical interest deals with chemically diverse types of these, including the heterocyclic vitamins. The chapter on alcohols, phenols and ethers is followed by appendixes dealing with: flavones, anthocyanins and other plant pigments; photographic developers; and alcoholic fermentation. The chapter on hydrocarbons has a very useful appendix on the Friedel–Crafts reaction.

I have noted a number of examples of inaccurate or misleading statements. The treatment of some subjects is not very modern, and this applies in some instances to the lists of works of reference given at the ends of the chapters. A selection of literature references, although not extensive, is a useful feature. The index is largely an index of compounds, and contains very few subject headings. This serves to confirm the impression that the book tends to be a compilation of data and an extensive series of notes rather than a readable treatise. Nevertheless, it may well be destined to take an important place among the advanced text-books of organic chemistry.

J. W. Cook

SCIENTIFIC RESEARCH IN INDUSTRY

The Organization of Industrial Scientific Research By Dr. C. E. Kenneth Mees and Dr. John A. Leermakers. Second edition. Pp. ix + 383. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 42*s*. 6*d*.

THE thirty years since the first edition of this book was published have seen a vast expansion of industrial research and the firm establishment of some co-operative institutions, both in Great Britain and in the United States, which in 1920 were no more than in the experimental stage. That growth is reflected in the expansion of this book from the nine chapters and 175 pages of the first edition to the twenty chapters and nearly four hundred pages of the present volume. The text, however, represents essentially a new book. It is written in three parts. The first, dealing with what are described as "general principles", reviews briefly the expansion of scientific and industrial research in the past three decades, the development of scientific organisation and the broad types of organisation for industrial research. This is illustrated by the survey of agencies for the conduct of industrial research, which constitutes the second part of the book.

The third part of the book, occupying rather more than two hundred pages, deals with the organisation and operation of industrial laboratories. There are chapters on the position and responsibilities of the research department in a company, internal organisation of the laboratory, selection of staff and of programmes, administration or direction of research, transfer of research to production, reporting of results, patenting, publications and library services, financial control, staff problems including salary administration, supplies and services, and laboratory design. In this part of the book the authors have drawn largely on their own experience of chemical and physical research, but to some extent also on the replies received from directors of a number of large industrial laboratories in answer to a detailed questionnaire on operating procedures; some further material was supplied by specialists who are not specified.

The book is a comparative survey of current practice rather than a contribution to the theory or philosophy of research, and though most of the important factors upon which the successful management and organisation of industrial research are indicated clearly enough, there is little attempt at a critical appraisal of their relative importance. Generally, the book is disappointing in that it attempts too much and succeeds in covering no part altogether satisfactorily. It does not always make clear where the authors are drawing on their own experience and where they are relying on or quoting from that of others. As a guide to the considerable literature on the management and organisation of research, it is incomplete, and bibliographical references are not only frequently imperfect but also are sometimes omitted altogether. The authors would have written a better book had they relied entirely on their own considerable experience or on material they collected by personal inquiry.

R. BRIGHTMAN

THE FLORA OF CALCAREOUS SOILS

Wild Flowers of Chalk and Limestone

By J. E. Lousley. (New Naturalist Series.) Pp. xvii+254+72 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1950.) 21*s*. net.

THE aim of the now well-known "New Naturalist" series is to interest the general reader in the wild life of Britain by recapturing the inquiring spirit of the old naturalists: and this most recent addition to the series fulfils the objective thoroughly.

The author's field for his work—the chalk and limestone areas—gives him a good start, for, as the editors point out, "few types of habitat can boast a larger proportion of rare and beautiful flowers than the limestone—nor more lovely scenery in which to search them out". The rare and/or beautiful can always be depended on to attract the field biologist, and if he has perforce to take some fellow travellers with him he can then depend on the scenery to make up for what the latter might lack in biological enthusiasm.

But all readers of this book will surely find "the inquiring spirit of the old naturalists" impelling them to forage on the limestone for themselves. To many this might not be possible; nevertheless, any such unfortunate readers can rest assured that what they themselves cannot do, Mr. Lousley has done for them, and done it exceedingly well. The entire text breathes the air of the field; so though, perforce, to some it might have to be armchair reading it certainly has not been armchair writing. Mr. Lousley is one of Britain's leading authorities on the flora of the chalk of south-east England; he has also visited most of the other limestone areas of Britain in both north and south.

The author opens his text with an account of the inter-relationships of plants and chalk and limestone soils. Of particular interest is his discovery that though the various habitats of the calcareous soils of Britain have their own inherent characteristics which are reflected in their floral cover, taken altogether they form a series gradually changing from east to west and from south to north. The reasons for the gradual changes, he has revealed as being due to variation in climate and to incidence of the geographical distribution of species. The latter is clearly a concomitant of the former.

The author does well to begin his detailed descriptions with the North and South Downs and the Isle of Wight, for here he can scarcely be challenged, and, being such an enthusiast, he inspires his readers with his enthusiasm. Once this is aroused, there it remains while the reader is taken over all calcareous areas in Britain.

The flora of chalk and limestone is well known to be especially rich in rare plants, so here is a great opportunity for an enthusiastic author—an opportunity fully grasped by Mr. Lousley. Moreover, some of these rareties are beautifully illustrated. For example, the military orchid (*Orchis militaris*), fairly well known a century ago, was, by 1914, regarded as extinct in Britain until, in 1947, Mr. Lousley rediscovered and fortunately photographed it in colour himself; this excellent photograph is reproduced in the book. Again, the grotesque-looking lizard orchis (*Himantoglossum hircinum*) is a very rare and, indeed, capricious plant; but Mr. Lousley sought it out and tells us all about it, and Mr. Robert Atkinson has supplied a splendid colour photograph of it. Then there is the baneberry (*Actæa spicata*), a curious member of the order Ranunculaceae, having small white flowers followed by purplish-black berries. This plant is naturally confined to a narrow band across the north of England; elsewhere it seems to have been introduced. Again we are presented with a colour photograph. These are three examples of the many good things botanical given in this admirable book. But, of course, the author has been thorough, consequently the common and less frequent plants are also described and many of them illustrated in colour or black-and-white photographs the like of which have already rendered the "New Naturalist" series so distinguished.

Appended to the text are: a series of sixteen distribution maps, a list of the vice-counties of Great Britain and the Republic of Ireland, a list of references, a bibliography and an index.

The whole work, both text and illustrations, does credit to the author and those who have produced the fifty-two colour and twenty-nine black-and-white photographs. It cannot fail to carry out fully its purpose in inspiring the field botanist already familiar with the flora of calcareous soils to delve even more deeply and intensively into the green carpet of the chalk and limestone, in stimulating those who are not so familiar with it to correct the omission and learn about this rather special flora, and in supplying the academic student of botany with a valuable supplementary text.

L. J. F. BRIMBLE

OPTICAL INVESTIGATIONS IN MOLECULAR AND IN CELL STRUCTURE

THE Discussions of the Faraday Society are well known all over the world: and they regularly attract distinguished visitors. The latest in the series of these Discussions was held during September 25–28 at Cambridge, and visitors from abroad accounted for nearly a hundred of the three hundred present. Almost every Western European country was represented, and a large group from the United States gave a most interesting international aspect to the whole affair. The first two days of the conference were devoted to a discussion of spectroscopy and molecular structure, the remaining day and a half being concerned with the applications of various spectroscopic and microscopic techniques to the study of cell structure.

Spectroscopy and Molecular Structure

Spectroscopy is so vast a topic that it can only be dealt with in sections. The most natural beginning—which was actually adopted—is with electronic spectra. In this field it was most interesting to see the changes that have taken place since this subject was last discussed by the Faraday Society. In the first place, all but one of the papers were concerned with relatively large molecules, such as naphthalene or pyridine. This expresses a shift of emphasis away from the well-worked diatomic molecules to that border region where possible relations are being sought between molecular properties and biological activity. It was really most impressive—and encouraging—to see that at last it is becoming possible to characterize the various bands that are observed. Theory plays its part by means of group theory, enabling decisions to be made concerning the symmetries of the allowed wave functions and the permitted transitions. But it goes even further, since many of the most interesting molecular spectra arise from what are technically forbidden transitions. Such transitions, which are usually relatively weak, are made possible by the presence of certain types of vibration, and by certain spin-interactions. The various possibilities can all be listed, so that now, for the first time, we really believe that we can assign some of the transitions in naphthalene and other members of the homologous series. The experimental work of Dr. M. Kasha, in the United States, was the outstanding paper in this section. His analysis of singlet–triplet transitions in substituted benzenes and naphthalenes, in which he has studied the way in which an increase in atomic number of the substituent increases the intensity of these forbidden transitions by breaking down the usual form of spin coupling, and introducing a spin-orbit interaction, will probably become classic.

In the second place, it was interesting to see the greater emphasis, also expressed in the contributions dealing with the infra-red and Raman effect, on intensities. Here is a much-neglected tool, the proper use of which is most powerful.

Two other points in electronic spectra deserve mention. The first is that we seem to have passed out of the stage in which exponents of one or other type of theoretical approximation (molecular-orbital or valence-bond) fought hard with the exponents of the other approximation. In certain cases a reconciliation has been effected, with concordant predictions; and in others, we understand the natural liabilities of the methods so much better that we now adopt an attitude of modesty when expressing our conclusions. Quite clearly, theory can help enormously; but it can never dispense with experiment. Secondly, thanks largely to the work of W. C. Price of King's College, London, we are getting on better terms with the so-called Rydberg levels in molecules; here an electron is excited to an orbit of relatively large dimensions, generally lying mostly outside the greater part of the molecule. The energies of these orbits fit into a Rydberg series, very similar to those found with isolated atoms. The quantum defect in the Rydberg expression gives indications of the *s*, *p*, . . . type of the transition, and the constant term gives valuable information about the ionization potential. Excellent progress is being made in understanding both of these, and in correlating them with the size and structure of the molecule.

The conference next turned to discuss the vibrational spectra of small molecules. Here the emphasis is quite different. Very little interest is now attached to the process of assigning frequencies and choosing force-fields; for the tools with which we study infra-red spectra are now fully grown-up. The modern double-beam self-recording spectrometers do in less than a minute what used to require about two weeks; and recent dispersing prisms have greatly extended the range of measurement, while new photocells have completely changed the precision of recording in regions up to 35 μ. As a result the technical problems are almost all solved; what is happening is a gradual transference of interest away from chemistry into physics and biology. In its physical aspects the detailed study of intensities is giving information about the variation of dipole moment with bond-distance, about the changes in configuration that take place on crystallization or other change of state, upon order–disorder phenomena and similar physical problems. In its biological aspects it is enabling us to follow chemical reactions taking place in many kinds of biological material. The most outstanding new applications are in low temperature and in the use of polarized infra-red radiation. Some of these will be referred to later.

It was inevitable that some consideration should be given to the competing claims of microwave analysis and more standard infra-red and Raman rotation–vibration methods for investigating molecular structure. Such a comparison was much stimulated by an excellent review of recent centimetre-wave work by E. B. Wilson. In certain recent microwave work bond distances have been given in angström units to four decimal places. This suggests that there might be some chance of the older and more conventional techniques being abandoned. But as Dr. G. Herzberg (National Research Council, Ottawa) pointed out, there is a quite astonishing agreement, usually to 1 part in 10^4 or 10^5, between moments of inertia determined by the two methods. This conclusion, which does not appear to have been sufficiently recognized hitherto, is very reassuring.

It is true that microwave measurements are often made with an accuracy about a hundred times greater than the infra-red and Raman measurements. But they are made on only one rotational transition (and even then, only on relatively simple molecules), and do not, by themselves, provide sufficient information to correct for anharmonicity of the vibrational motion. As a result, they do not allow us to pass from B_0 and D_0 (constants of the vibrating molecule) to B_e and D_e (constants of the non-vibrating molecule). At present, also, microwaves can only be used with unsymmetrical molecules. It was with something approaching relief that the infra-red spectroscopists heard all this, and very happily came to the conclusion that their subject was not yet outmoded. To me it seems probable that a combination of the older and newer techniques will prove most fruitful, in which the wider applicability of the one approach is supplemented, at suitable points, by the intrinsically more accurate, though less versatile, character of the other. The agreements already reached are a most welcome augury in this direction.

Nevertheless, the infra-red exponents had no cause for dismay—at this very meeting they described how there was an almost completely unhindered rotation in zinc and mercury dimethyl; they gave, for the first time, a molecular shape and size to the HNCO molecule, they showed that in AsH_3 and PH_3 there appears to be no measurable inversion spectrum such as is found in NH_3; they found evidence for two related, but dissimilar, forms of the nitrate ion NO_3^- in metallic crystals, and they discussed the interactions between lattice vibrations and internal vibrations in molecular crystals. This is substantial progress, showing that the early technical improvements of Dr. H. W. Thompson and Prof. G. B. B. M. Sutherland are continuing to bear fruit.

Yet the outstanding paper in this section was due to Prof. R. Mecke, of Freiburg-im-Breisgau, who reported briefly on a series of about a dozen papers published from his Institute in recent years. All were concerned with the 'hydrogen bond' resulting from association of alcohols. What was most impressive about these papers was the breadth of the attack made to converge on this one problem. Thus dielectric constant measurement, conductivity measurement (showing a small, but quite definite and measurable, proportion of ions due to the migration of the proton from one oxygen atom to another), absolute intensities of a series of overtones of the fundamental frequency of vibration, ultra-violet absorption, and thermal effects: all these were made to provide a picture of some of the characteristics of the O—H . . . O bond which could not possibly have been obtained by one technique alone. This interplay of various techniques was a valuable and stimulating warning against a too narrow outlook. One interesting by-product of this work was that Mecke was able to derive the famous Morse potential function for molecular vibrations. This was previously entirely empirical.

It is more difficult to comment on the last section of this part of the conference, which was concerned with the vibrational spectra of complex molecules. Quite clearly no one is going to try assigning force fields, so that the part played by theoretical argument is very small. Much of the work is in the nature of diagnosis, using known frequency charts to infer the existence of certain types of bonding. Intensity studies are able not only to show which types of bond occur, but also how many of them there are. Thus in saturated hydrocarbons we can estimate the ratio of the number of tertiary and primary carbons; and in unsaturated hydrocarbons the number of double bonds. We can also follow the migration of the double bonds that accompany the chlorination of rubber. It is a great pity that the whole basis of this work—the constancy of vibration frequency of individual bonds, or groups of bonds—is still not adequately understood theoretically. But some preliminary work has already shown signs of success in sorting out the 'skeletal' vibrations of a long-chain molecule from the 'rocking' and 'wagging' frequencies of individual units along the chain.

As an empirical tool, the most noteworthy recent applications of infra-red investigations to large molecules are in the use of polarized radiation; for by controlling the direction of polarization relative to the crystal, we can trace the directions in which, for example, most of the N—H . . . O bonds of a protein system are oriented. We can distinguish between folded and extended protein chains, and the process of crystallization can be followed in a most effective manner. The significance of this technique as a tool for investigating crystal structure is that the absorption of radiation is highly specific to certain bonds, and in this way we have a kind of 'probe' that can penetrate easily into the system, by-passing groups of atoms in which we are not interested, and telling us about the orientation of bonds that would otherwise be inaccessible. It may be true that there is still need for caution in interpreting the observations, but there is no doubt whatever that an enormous field of application of this type of study to systems of biological interest lies open to be exploited.

The Discussions of the Faraday Society have a habit of marking turning-points in their subject. Very few people would deny that this was true in the field of electronic and vibrational spectra, as revealed in the recent Discussion at Cambridge.

C. A. Coulson

Optical Methods of Investigating Cell Structure

The second part of the Faraday Society Discussion was an intentional departure in subject from anything the Society has previously attempted, and marks a direct recognition and encouragement by the Society of biophysical research. In 1929 a Colloid Committee was formed and has been of great value in stimulating and suggesting Discussions. This Committee has recently been reconstituted as the Colloid and Biophysics Committee, and has already been responsible for the important meeting to discuss lipoproteins, held at Birmingham last year, together with a number of other locally organised discussions, such as those on nucleic acids, water transport in plants, and the electrical double layer.

The Faraday Society, which, since its foundation in 1909, has had such an important influence on the development of the common ground between physics and chemistry, now recognizes at a critical period the borderline subjects associated with physics, chemistry and biology; and it is the intention of the Society to encourage publication in this field. In reviewing the Cambridge meeting, I shall not attempt a detailed report of all items of discussion, but rather to give the background and set out briefly the main features of importance which arose.

The microscope has always, for obvious reasons, been a fundamental physical tool in cytology. During

the past twenty years the development of phase-contrast microscopy, the reflecting microscope—and in a wider field the electron microscope—have led to new attempts to understand in a more fundamental way the structure and function of the cell. The value of the spectroscope in biology has long been recognized, but attempts to combine microscopes and spectrographs satisfactorily are comparatively new. Since 1936, Caspersson and his colleagues in Stockholm have made use of the long-known ultra-violet absorption of the purine and pyrimidine components of the nucleic acids in a detailed study of cells. The physical assumptions underlying the accurate appreciation of such methods have not been very well understood, and the time seemed peculiarly appropriate for the discussion under review.

Seventeen papers were presented at the meeting; broadly speaking, these fell into three groups. Apart from the introduction by the writer, which ranged over the implications of the discussion as a whole, the first group of papers was largely concerned with instruments, their design and proper use in the study of biological material.

The design of reflecting microscopes and the performance of these instruments came in for a good deal of lively discussion, started by R. Barer (University Museum, Oxford), in which K. W. Norris and M. H. F. Wilkins, of King's College, London (as authors of papers), and Keohane and Wilfred Taylor took part. Two types of reflecting microscope have been developed in Britain. The pioneer work on aspherized reflecting objectives has been done by Burch, and it is understood that some of these with 0·65 numerical aperture and 14 per cent central obstruction will be available before long. The difficulty of making aspherized surfaces on a large scale probably means, however, that such instruments will always be expensive. The other design of reflecting microscope in Britain, using simple spherical surfaces, is due to Wilkins, Norris and W. E. U. Seeds at King's College, London. An instrument with a numerical aperture of 0·65 and 35 per cent central obstruction is already commercially available. A third design, due to Grey in the United States, employs mirrors and lenses and is said to have a numerical aperture of 0·72 and obstruction ratio of $\sim$ 30 per cent.

The chief point of discussion arose over the appropriate measurement of coma in the simple spherical surface objectives. Unpublished calculations by Grey (presented to the meeting by Barer) indicated that the coma-free field would be small. The experimental approach of Wilkins and collaborators utilizing a microscope interferometer test, together with study of pinhole diffraction images, appeared to show that a wider field is coma-free and entirely adequate for microspectrometric studies on cells and their components.

The discussion on these matters was largely concerned with the question as to whether the reported computations of Grey are equivalent to the stringent experimental tests applied by Wilkins and Norris to their own objectives. Coma was defined by Wilkins and Norris as just allowable at any point in the field where the intensity of the second diffraction ring in the image of a point object is equal to the intensity of the first ring on the other side of the maximum. Whether such a definition of effective field-size falls within the arbitrary criterion of the Rayleigh limit, presumably only the wave theory of aberrations can show; no doubt this point will be cleared up at a later date. The further question as to whether an aspherized Burch objective is suitable for such purposes depends on the allowable degree of 'cobbling' discussed by Wilkins in his paper, and by Keohane at the meeting. A number of calculations by Wilkins on the size of object, and other problems, in relation to accurate absorption measurements, were also presented.

Infra-red microspectrometry has been attempted on a number of biological objects during the past two years, but the resolving power revealed in the work so far published has been low. The interest of the paper by Fraser, in which a 0·8 numerical aperture reflecting microscope was successfully combined with a Grubb Parsons infra-red spectrometer, rested on the very high spectral resolution obtained, which ranged from 8 cm.$^{-1}$ at 3,000 cm.$^{-1}$ to 2·0 cm.$^{-1}$ at 1,000 cm.$^{-1}$. Kletz also reported the design by Bosanquet of a reflecting objective of similar aperture for use in the infra-red.

A reminder that macrospectrometric measurements are still of great importance was given in the paper by G. H. Beaven and E. R. Holiday (London Hospital), and by E. M. Jope (Queen's University, Belfast), on ultra-violet absorption spectra of aromatic amino-acids in proteins and related compounds. The absorption spectra obtained by the logarithmic cam technique were extremely fine.

The use of microspectrographic methods in the study of crystals of biological interest was also aptly illustrated in the second group of papers presented by Seeds and Wilkins (tobacco mosaic virus, tyrosine), and M. Perutz (Cambridge), E. M. Jope and R. Barer (horse methæmoglobin); polarized ultra-violet light was used in all these investigations, and Seeds also described the design of a low-temperature stage for the reflecting microscope.

A. Engström (Institute for Cell Research, Stockholm) described work on the investigation of a number of tissues by his now well-known and elegant X-ray absorption technique, which allows of the accurate estimation of sulphur, phosphorus and calcium. Work on the much more difficult problem of estimating carbon, oxygen and nitrogen is in progress. Thorell gave an account of a single-beam recording microspectrograph, working in the short wave-length visible range, for the study of end cellular hæmoglobin synthesis. H. Hyden (Göteborg) presented studies on human nerve cells in relation to the yellow pigment in the cytoplasm, which is at present thought to be a pterin.

These papers, and the remaining ones by H. G. Davies and P. M. B. Walker (King's College, London), B. Commoner (Washington University), Catchpole (University of Chicago), and Bradfield (University of Cambridge), brought out several features of interest. The enthusiastic application of microspectrometric methods which has taken place since the War has perhaps led to the view that such methods could give, unaided, unequivocal answers to many fundamental questions, such as those involved in the relations of nucleic acids to protein synthesis. Such problems are essentially dynamic in nature, and it is unlikely that solutions will be obtained by static methods alone. It was refreshing to find all workers thinking very critically concerning the choice of biological material likely to lead to the most valuable results. On one hand, there is the clear-cut geometry of the epidermal hairs of plants such as *Coleus*, discussed in the elegant work of Commoner; on the other, sections of pathological tissue. Intermediate between these

extremes are tissue-culture preparations such as those used by Davies and Walker. The paper by Davies brought out very clearly the problems of ultra-violet dosage of living cells, and a film shown by Walker demonstrated the effects of continued dosage on the nucleus and cytoplasm. So far as one can judge at the present time, there is just as much danger in the indiscriminate use of qualitative ultra-violet photography as there is in over-stressing the quantitative determination of metabolites by microspectrometric methods. The effects of fixatives on the biological material are as yet only rather vaguely apprehended, and it was interesting to note the measurements of Engström using the X-ray absorption method, which demonstrated in certain instances that the use of formalin caused a decrease in mass of tissue, while the use of Carnoy led to an increase. Freeze-drying left the tissue unchanged in this respect.

The ripples which have spread from the pioneer work of Caspersson have now affected many groups in all parts of the world, and perhaps the most significant result of the Discussion lies in the healthy critical attitude adopted by all to the use of microspectrometry in biology. The results of this will, of course, only become apparent in the future. On the other hand, it is clear that the present time is bringing forward new and improved optical methods for the study of microscopic objects, biological or otherwise, and important results are already being obtained on virus nucleoprotein and crystals of biological relevance. The discussions also made it clear that fundamental progress in all these fields can best arise from the close collaboration of physicists, chemists and biologists, in the focusing of many methods and techniques on the problems which arise.

J. T. Randall

POPULATION STUDIES OF GREAT BRITAIN

VOLUME 2 of "Papers of the Royal Commission on Population"* comprises more than a dozen reports and papers of the Statistics Committee. Although all deal with related topics each is largely self-contained, so the publication is not intended to be a unified contribution to demography.

In studying the occurrence of events in a population by statistical methods, a fundamental principle must be observed if the most efficient use is to be made of the data. The principle is, in brief, that as much concomitant information shall be available about individual members of the population who do not experience the events as about those who do. This principle is often met in practice by choosing a suitable random sample of unaffected individuals for study as a control group. In demography, however, the procedure is to relate the numbers of persons experiencing the events to the appropriate population among whom they arise. In either case, any concomitant information which is available for those experiencing the events, but not for members of the control group (or for the whole population), is of limited statistical value.

The lack of a census for Great Britain in 1941 meant that the extensive information on fertility, obtained since July 1938 at birth and death registration, could not be related to equally comprehensive population statistics. The difficulty was partly met by unpublished population estimates by age, marital status and duration of marriage, which were supplied to the Statistics Committee by the General Register Office; but even so, the analysis of fertility statistics could not be as complete as was desirable, and those analyses which were made must have a considerable margin of error. It might have been expected that one of the first uses of the 1946 Family Census would have been to remedy these deficiencies, at least for the female population. It is therefore most puzzling that no such use of the Census material is even considered in the present volume, although, apparently, the necessary basic tabulation was made. In particular, it is very regrettable that, two years after the Census was taken, the research assistant of the Statistics Committee, Mr. J. Hajnal, had to embark upon an extensive study of reproductivity with only the Registrar General's approximate, and incomplete, population estimates. This inevitably restricts the scope of Mr. Hajnal's important contribution to demographic methodology.

Despite these imperfections, the fertility analyses do demonstrate beyond doubt the phenomena of 'postponement' of births and the subsequent 'making-up' which are characteristic of marriages in the period 1940–47, as compared with 1938 and 1939. The beginnings of the process can be discerned for first and second births by the end of 1943. It is shown, too, that the total number of legitimate births in the years 1939–47 was similar to the number which would have been expected if the 1938 figure of 1·93 births per marriage had persisted throughout those years. In other words, the made-up births approximately equalled those postponed. The discovery of this pattern underlying the fluctuations in birth- and marriage-rates during the War years is of considerable demographic and sociological interest.

The Family Census, which was taken in January–February 1946, was based upon a 10 per cent sample of women throughout Great Britain who were or had been married. Although no compulsion could be exercised, at least 87 per cent of the women in the sample responded. Various indirect tests showed that an unduly high proportion of those who did not respond must have been childless, and the results have been suitably adjusted. The preliminary report contained in the present volume gives a clear account of the practical aspects of the Census procedure, from the necessary organisation to the methods of adjustment and analysis. It also presents provisional results concerned with 'family size' (which means here the average number of live births per woman after a certain duration of marriage). It is not made sufficiently clear that these figures refer (naturally) only to those women who have survived to the Census date. There is good reason to suppose that mortality (and perhaps migration) is correlated with fertility—certain forms of cancer are well-known examples—and this may introduce a bias in the absolute figures which could be substantial for the earlier cohorts of marriages. However, the trend shown by the Census results is unlikely to be seriously misleading; and this brings out a second main point of demographic interest, namely, the recent stabilization of family size in Great Britain after a decline lasting for more than half a century. Despite the violent war-time disturbances in birth- and marriage-

* Papers of the Royal Commission on Population. Vol. 2. Reports and Selected Papers of the Statistics Committee. Pp. viii+422. (London: H.M. Stationery Office, 1950.) 8s. net.

rates, the family size after ten years of marriage (which is a good indication of complete fertility) is reasonably constant for women who were first married in each of the years from 1927 to 1938. Mr. Hajnal's analysis of birth registration statistics confirms this.

The Statistics Committee is evidently, and rightly, impressed by these findings. The stability of family size for marriages contracted in the twelve years before the War, together with other considerations, leads the Committee to attach much importance to 'family size' as a statistical concept in the study of reproductivity. But the equivalence, during the period 1939–47, of the made-up births to those postponed is an encouragement to endow the same phrase with a more literal, sociological meaning, and to suggest that a certain total size of family may be a fundamental objective of the individual marriage. The hypothesis is undeniably attractive, and so there is a real danger that it may be accepted uncritically as the only valid explanation of the statistical facts. It has been shown that married couples reacted to one set of environmental circumstances by restricting births, and to another by bearing children more freely. Just because one process balanced the other over a certain period of time, it does not necessarily follow that married couples as a group were exhibiting a fixity of purpose with regard to the ultimate size of their families. Still less can any conclusion be drawn concerning the individual marriage. To proceed from the general to the particular can be as dangerous as the reverse.

It is of interest to compare the experience of the two World Wars. Family size was stable at all durations of marriage above eight or nine years for those marrying for the first time in each of the years 1915–20. The birth statistics during 1914–22 show the characteristics of postponement and making-up, but the latter process was far from complete. It is already apparent that the recent pattern is distinguished by the stability of the average family size of pre-war marriages, and by the completeness of the making-up of births. Viewed as a more intense manifestation of similar processes, however, recent events suggest that there will be a rise in average family size for those married during the War, and possibly a decline for those married since. It cannot be assumed that the stability, which is at present apparent, is evidence of future stability, and the Statistics Committee makes it clear that it is well aware of this.

In addition to these striking demonstrations of the value of the methods of analysis permitted by the new statistics on fertility, the Committee devoted much thought to the problem of measuring reproductivity. Mr. Hajnal's report, although certainly not the last word on the subject (witness the reservations expressed by Mr. V. P. A. Derrick and Dr. P. Stocks), does represent a most important contribution to the understanding of this technical problem. The fundamental difficulty in finding an adequate measure of reproductivity is simply that any measure must assume the indefinite continuance of certain demographic features in the population. Even if these assumptions are theoretically acceptable, in the sense that they will ultimately ensure a stable population (as well as being in themselves reasonable), other demographic features in the existing population will inevitably alter in the process. These changes will make the indefinite continuance of the chosen features less plausible or even improbable. This difficulty applies with particular force to any reproduction-rate involving one sex only. Mr. Hajnal develops a theory of reproduction-rates based upon marriage and the fertility of marriages, which, although it does not overcome this particular difficulty, simplifies the handling of it. He then applies the theory to the derivation of four equally acceptable measures of reproductivity from a given set of marriage and fertility data, in order to specify the range within which 'true' reproductivity will probably lie. In view of the recent fluctuations in birth- and marriage-rates, he is unable to set limits for present-day reproductivity closer than 0·83–1·00; but even this suffices to show that, if people continue to marry and have children at the rates prevalent in recent years, the population of England and Wales will ultimately decline.

Mr. Hajnal also examines the effects of a change in the age of marriage upon other demographic measures such as the birth-rate; this is a particular aspect of the general problem of the interaction of such changes in demographic phenomena. The report contains a great deal more than this brief appraisal might suggest, and it deserves close study by all demographers.

Several of the papers deal with the problem of deriving projections of the population of Great Britain during the next hundred years. As one mortality basis for these projections, a life table was prepared by the Government Actuary's Department to summarize the mortality experience of Great Britain (civilian war mortality excepted) during 1942–44. A non-actuarial eyebrow may perhaps be raised at the description of this table as 'hypothetical', which would scarcely seem to distinguish it from any other life table. Surely 'estimated' would have been a better expression. Another basis for projection was provided by a series of exponential trend curves fitted to the age-specific death-rates of 1901–45, and produced as far as 1978. A particularly interesting section of this report explores the possibility of using projections based upon the hypothesis that the mortality of each generation is largely determined throughout life by inheritance or early environment.

The actual population projections involved postulates of marriage- and fertility-rates and of migration, as well as of mortality, and a wide variety of assumptions was formulated. All those on fertility were specific to duration of marriage and not to the age of the mother, as has been customary in the past. This meant that marriages had to be projected as a first step towards the projection of births. The whole process was facilitated by dealing throughout in five-year age groups, and projecting five years at a time with mortality, marriage and fertility assumptions expressed in life-table form. Altogether, sixteen projections were made with various combinations of assumptions, and the detailed results occupy more than sixty full-page tables. There is plenty of material here for anyone anxious to discern the relative influences of possible mortality, fertility, marriage-rates and migration upon the future course of population in Great Britain.

Finally, the Statistics Committee makes a number of practical recommendations to the Royal Commission. It points out the need for census data on fertility to be obtained regularly, and suggests modifications and extensions of the existing registration procedures to facilitate adequate demographic

analyses. Its original hope was that a Family Index might be instituted, which would collate fertility information for each marriage throughout its course on a central 'family card'. The Registrar General indicates the difficulty of maintaining such an Index with any accuracy, and rejects the proposal mainly on the ground that, although the Index would be additional to periodic fertility censuses, it would not yield much additional information. The Committee further recommends certain internal changes in the General Register Office of England and Wales to strengthen its status as an instrument for the study of population statistics. It considers that demographic statistics should be available for Great Britain as a whole, and not only for its separate parts, and asks that arrangements shall be made for the production of detailed statistics for the whole area. In this connexion, the present volume contains a series of tables of demographic statistics for Great Britain, in some instances covering a period of more than a century, and compiled principally from the reports of the Registrars General. IAN SUTHERLAND

THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

By PROF. F. J. M. STRATTON, O.B.E., F.R.S.
General Secretary

IN 1946 the first General Assembly after the War of the International Council of Scientific Unions was held in London. The desire to renew and invigorate international co-operation in the various sciences after years of enforced isolation was strong on all sides, and a valuable ally to active development was represented in Dr. Joseph Needham, head of the Natural Sciences Division of the United Nations Educational, Scientific and Cultural Organisation. He was the herald of generous financial aid to the Council and its Unions by means of grants-in-aid from Unesco, totalling each year some 200,000 dollars. These have assisted international gatherings and movements of younger scientific workers, by contributions towards travelling expenses, and also publications and the rehabilitation of scientific stations of international standing. It was no doubt due to the fact that international science was already so well organised in many branches that a good case could be made out from the start of Unesco for grants-in-aid that would usefully be spent in bringing together in friendly conference representatives of many countries—one of the best ways of forwarding peaceful relations among the nations.

Some of the well-established Unions—Astronomy, Geodesy and Geophysics, Chemistry and Radio-Science—quickly returned to their former activities on well-established lines. To others—Physics, Biological Sciences and Geography—came a new lease of life and greatly enhanced activity. Fresh applications for the admission of new unions soon came along, and within a year three were admitted by the Council—Unions of Crystallography, Theoretical and Applied Mechanics, and History of Sciences. Some opposition was offered to the acceptance of new unions in rather specialized fields; but the view that we should feel our way experimentally in the fluid state of affairs following the War prevailed. Two classes of unions now exist, namely, General Unions, covering a wide basic field, and Specialized Unions.

The whole policy of admission of new unions is at present under review. There are two conflicting views. One is that to have too many unions would make the whole organisation unwieldy and would lay too heavy a burden on the national adhering bodies that carry the chief financial load of supporting the unions and the Council. The other is that it is the Council's responsibility to assist the development of science, especially in the newer and rapidly growing subjects, and that so far as possible the Council should cover the whole range of science. The difficulties can be partly, but not wholly, met by attaching new bodies to existing unions and by divisions of unions into sections. Basically, however, the fact has to be faced that fresh developments must involve increased financial support, and that considerations other than finance must be given full weight in coming to any general decision.

The past history of the Council and its Unions has been described in a pamphlet on the Unions prepared by Dr. John A. Fleming, a past president of the Council, and issued by the Council. It gives short historical accounts of the Council and the Unions, details of their publications, statutes, officers, sections and organisation generally; altogether, it gives an impressive picture of the extent to which, in some subjects at least, international co-operation has forwarded the progress of a particular branch of science.

One of the newer developments of the International Council of Scientific Unions since 1946 has lain in the formation of joint commissions to cover ground lying between the domains covered by two or more unions; radiobiology and rheology may be quoted as examples. In these cases a commission comes especially under one union, its mother union; but members are nominated by the other unions concerned. It is anticipated that such joint commissions will in due course be absorbed by the union that turns out to be chiefly interested, arrangements being made for other bodies to be represented in their membership.

Another body which has existed under the International Council since 1937 is a Committee on Science and Social Relations. This Committee has had to steer its way carefully between political questions, which do not fall within its terms of reference, and idealist statements which lack the desired practical effectiveness. No one will deny the great importance of the problems that it has to face; but it must be admitted that, on the whole, the organisations adhering to the International Council are not as actively interested in its activities as its originators had hoped.

One difficulty common to the International Council and its Unions is felt more particularly by the Council itself, and that is the need to keep a living contact with the more distant parts of the world. Europe, as was natural in 1919 when its predecessor the International Research Council was founded, has been all along its centre of activity: its General Assembly has never met outside Europe, and nearly half of its forty-three national adhering bodies are European countries. Though the modern ease of travel has brought the countries of the world as a whole nearer together, the greatly increased cost of travel has made meetings in the more isolated countries more difficult to arrange. Regional decentralization

may be the solution; but there are difficulties in the way of dividing up a fully international organisation, and the right answer may be close co-operation with existing regional bodies, such as the Pacific Science Council.

Finally, just a few figures about the International Council at the present moment. It has forty-three adhering countries, while the ten Unions have a number of adhering countries ranging from eleven to thirty-seven. It has ten Unions and eleven Joint Commissions; of the ten Unions, five, namely, Astronomy, Geodesy and Geophysics, Chemistry, Physics and Biological Sciences, are General Unions; while the other five, Radio-Science, Geography, Crystallography, Mechanics and History of Sciences, are Specialized Unions. The International Council is one of a small group of non-governmental international organisations that have formal agreements with the United Nations Educational, Scientific and Cultural Organisation, which recognizes it as providing a natural and appropriate form for the international organisation of science. A liaison officer, Dr. R. Fraser, established at Unesco headquarters, assures close co-operation between the two bodies. The president of the International Council is Prof. A. von Muralt, professor of physiology at the University of Berne, and director of the High-Altitude Research Station on the Jungfraujoch.

WATER CONSERVATION IN TERRESTRIAL ARTHROPODS

A DISCUSSION on "Water Conservation in Terrestrial Arthropods", arranged by Section D (Zoology) of the British Association, was held in Birmingham on August 31.

Owing to the small size and relatively large surface area of most arthropods, water conservation is a matter of vital importance, particularly to those species living in dry environments. Indeed, this need is often reflected in the anatomy and physiology of many of their organ systems; for example, in the closing mechanisms of the spiracles, in the digestive and excretory systems and, not least, in the cuticle and egg-shell. Since most attention has recently been focused upon the latter topics, it is natural that the discussion at Birmingham should have been devoted largely to the water-protective properties of arthropod cuticle and egg-shell.

A general introduction on the cuticle was given by Dr. V. B. Wigglesworth, who recalled the main growing-points over the past ten years. The typical hardening and darkening of the insect cuticle which arise from the tanning action of quinones on a water-soluble protein was discovered by M. G. M. Pryor. The process, just as in the tanning of leather, has the further effect of rendering the material hydrophobe and receptive to waxes and other waterproofing agents. A few years previously, J. A. Ramsay had pointed the way to further advances in our understanding of waterproofing mechanisms by his work on the cockroach cuticle. Among other findings he showed that the evaporation of water from the cuticle does not vary in a linear manner with the saturation deficit but, owing to a change in the physical properties of a waterproofing grease present at the cuticle surface, increases abruptly at a critical temperature of about 30° C. This observation was later extended by V. B. Wigglesworth to other insects. Marked specific differences were found; in general, the more resistant the insect to desiccation, the higher the critical temperature. These variations were in turn related to the variable nature of the cuticular waxes, which were found to have graded properties when extracted. Conclusive evidence that the typical break in the temperature/evaporation curve is indeed due to changes in the properties of the waxes and not to any other component of the cuticle was advanced by J. W. L. Beament, who extracted and deposited the waxes on artificial membranes; the evaporation curves of such membranes showed critical temperatures closely approximating to those of the intact insects from which the waxes were obtained. The more rapid passage of water at the critical temperature is probably caused by a disturbance in the alignment of the wax crystallites owing to thermal agitation.

As a result of these and other studies on the mode of action of solvents and abrasive dusts on the cuticle, a new interpretation of epicuticle structure was proposed. Shown by the light microscope as an apparently uniform membrane, these indirect methods revealed the epicuticle as composite and built up from four very thin superimposed layers of tanned protein (cuticulin), polyphenols, wax and a cement-like covering substance.

Dr. J. W. L. Beament next described his more recent work on the waterproofing mechanisms of insect eggs. After briefly reviewing the remarkable range in size and shape of different eggs, he directed attention to the fundamental structural characters which render compatible the essential functions of mechanical rigidity and ability to hatch, water-conservation and respiration. The insect egg-shell consists of superimposed layers of protein which may be altered by tanning or other processes. All these layers are primarily water-permeable. Like the cuticle, the shell is made waterproof by the deposition of continuous films of wax or oil, although in some examples an existing layer may become impregnated with lipoid. But their arrangement is 'inside out', for the waterproofing layer is usually situated inside the shell and not at the external surface.

Various types of waterproofing systems can be traced. In what is perhaps a primitive condition, as exemplified by the tick egg, the wax is smeared on the outside of the egg by a special waxing organ. In *Dixippus* and apple sucker eggs, the waterproofing agent is also contributed by the mother and consists of an oily grease incorporated between the layers of the chorion. On the other hand, in such typical eggs as those of the blowfly and aphid, the wax layer is internal and is secreted by the oocyte. In *Rhodnius* there are two such internal layers laid down at different stages in the development of the egg. Dr. Beament concluded by describing the formation of the wax layers in *Rhodnius* and in the fruit tree red spider mite, both of which possess waterproofing layers of the double type.

It was a particular pleasure to hear Dr. E. H. Slifer, of the University of Iowa, describe her elegant researches on the conservation of water in the egg of the grasshopper *Melanoplus differentialis*. Here the main point of biological interest centres around the control of water uptake, since this phenomenon is intimately related to the onset and elimination of diapause. The fully formed egg-shell is again a

multi-layered structure of great complexity. When the egg is laid, the shell consists of the chorion, secreted by the follicle cells of the mother, and, passing inwards, the primary wax layer and vitelline membrane, both secreted by the oocyte. During the first three weeks of development, further layers, the yellow and white cuticles, are in turn added to the inside of the shell by the secretory activities of the embryo. The yellow cuticle is at first porous over the hydropylar region, but becomes impermeable to water at the three-week stage immediately before the onset of diapause. The passage of water through the shell is controlled by the orderly deposition or dissolution of these waterproofing layers. For one week after laying, the entry of water is prevented by the primary wax layer. This barrier is then broken down and water continues to enter the egg until halted by the deposition of the secondary wax layer associated with the yellow cuticle. At the termination of diapause this is in turn broken down, water again enters the egg and embryonic development recommences.

Widely differing powers of limiting evaporation from the cuticle are also found in other groups of terrestrial arthropods, for example, spiders and ticks. In the latter group, as in insects, these differences have been found to be a reflexion of the nature of the cuticular waxes, which vary in efficiency as waterproofing agents from species to species. Dr. A. D. Lees spoke of the probable ecological significance of such differences. The typical ground habitat in a representative series of ticks ranges from moist hill pastures in temperate climates (the sheep tick, *Ixodes ricinus*) to dry sandy localities in tropical regions (*Ornithodoros* spp.). The ability to resist desiccation is closely linked with the available moisture in the environment; the drier the environment the more resistant the species it harbours. The significance of waterproofing efficiency as an ecological factor limiting spread to new environments was illustrated by reference to two species of *Ixodes* with an overlapping distribution. Owing to its susceptibility to desiccation, *I. ricinus* is prevented from colonizing a relatively dry habitat which is suitable for its better protected relative *I. canisuga*.

The water relations of woodlice, which were discussed by Dr. E. B. Edney, provide several contrasting features. Although they live in a variety of situations ranging from the wet (the littoral species *Ligia*) to the comparatively dry (*Armadillidium*), the rate of transpiration through the cuticle, and particularly through that of the pleopods, is always high in comparison with insects. Moreover, the temperature/evaporation curves in all the species examined bear a linear relation to the saturation-deficit and show no break or critical temperature. This evidence, therefore, favours the view that no waterproofing layer is present in the epicuticle. Nevertheless, rapid transpiration may serve a useful purpose under certain conditions. Measurements have shown that evaporation into dry atmospheres can result in a marked fall in the body-temperature. This mechanism, which would be effective in cooling these animals for short periods up to one hour in duration, may enable woodlice to escape the effects of high temperatures. Compared with the Insecta, however, Isopoda have been unsuccessful land colonizers. Two important factors which have limited their distribution on land are, Dr. Edney suggested, their lack of an impermeable cuticle and their low temperature-tolerance. A. D. Lees

OBITUARIES

Sir William Benham, K.B.E., F.R.S.

The death occurred in Dunedin, New Zealand, of Sir William Benham, who for thirty-nine years was professor of biology (later zoology) at the University of Otago, New Zealand. Born at Isleworth, Middlesex, in 1860, he was educated at Marlborough College, being intended for the Indian Civil Service; but later it was decided that he should study for the profession of analytical chemist. Towards this end he went to University College, London, and it was here that he came under the influence of Ray Lankester, who gave the young student great encouragement and finally directed his steps to zoology. In 1883 he graduated B.Sc. (London) and completed his D.Sc. in 1887, his subject being earthworms. After graduating he was sent by Lankester to Kiel to study karyokinesis under Fleming, who was then the leading authority on this new subject; but Benham's interest remained with earthworms, much to Lankester's disappointment. In 1890 he went with Lankester to Oxford, where he remained as Aldrichian demonstrator until he left for New Zealand in 1898.

Benham's first paper on the testis of *Limulus* was published in the *Transactions of the Zoological Society* in 1883, the problem being set by Lankester, who was at the time interested in the relation of *Limulus* to the Arachnida. Another paper on the complete muscular and skeletal systems of *Limulus* was published before he began his life-work on earthworms. In this he was greatly helped by Jeffrey Bell, of the British Museum, who made available to the young enthusiast a world-wide collection of earthworms.

Although he published more than sixty papers on this group, Benham is equally well known for his publications in other groups. His Part IV of Lankester's "Treatise on Zoology", dealing with Platyhelmia, Mesozoa and Nemertines, is a very valuable book of reference. His account of the British Polychætes in the "Cambridge Natural History", published in 1895, is still the only detailed account of this group in the English language. From time to time he was asked to examine collections of Polychætes—from the *Endeavour* on the Australian coast, from the Mawson Antarctic Expedition and from the *Terra Nova* Antarctic Expedition. Benham was especially pleased at being invited to examine the last, in 1921, although he had been living for so many years in the Antipodes.

In New Zealand he kept up his interest in Chætopoda; but he also described representatives of other groups—Balanoglossids, Hirudinea and Gephyræa, and at the other end of the scale he examined whales, living and extinct. Birds, too, the moa and the *Notornis*, interested him.

Altogether, some hundred and thirty papers were published over a period of sixty-seven years, and some of the figures illustrating these have been reproduced in text-books by English, American, French and German authors. In his retirement he continued his research and kept up a wide correspondence with farmers in connexion with earthworms and agriculture. His last paper, written in his ninetieth year, is now in the press.

Sir William Benham was a most engaging personality, combining an old-world courtesy with authority and breadth of learning. He was an expert lecturer; even those who had heard many and able lecturers were always refreshed by Benham's approach to his subject and his slightly acid touch. He was

always at home with his subject, so his discourse was quite untrammelled by nervousness or reserve, and took on an intimate quality which was very appealing. In the circle of his friends, Benham's company was prized for its whimsicality and freedom from cant and hypocrisy, while his undoubted histrionic ability made him a raconteur of the first order. A man of strong personality and unusual charm, he will be greatly missed by those who knew him.

MARION FYFE

WE regret to announce the following deaths:

Sir Frank Gill, K.C.M.G., director and vice-president of the International Standard Electric Corporation and other bodies concerned in telephonic communications, past president and honorary member of the Institution of Electrical Engineers, on October 25, aged eighty-four.

Dr. G. A. Hankins, director of mechanical engineering research in the Department of Scientific and Industrial Research, on November 2, aged fifty-five.

NEWS and VIEWS

Nobel Prize for Medicine for 1950

THE Nobel Prize for Medicine for 1950 has been awarded jointly to Dr. Philip Showalter Hench, of the Mayo Clinic, Rochester, Minnesota, Prof. Edward Calvin Kendall, of the Mayo Foundation, Rochester, and Prof. Tadeus Reichstein, of the University of Basel. The award can be regarded as a recognition of the work which has been done leading to the dramatic opening of a new field of scientific medical research—that of rheumatoid arthritis and related diseases. Early in 1949, Hench, Kendall, Slocumb and Polley (*Proc. Staff Meet. Mayo Clinic*, **24**, 181; 1949) reported on "the effects of the hormone of the adrenal cortex (17-hydroxy-11-dihydrocorticosterone: Compound *E*) and of pituitary adrenocorticotropic hormone on rheumatoid arthritis". This was followed soon after by a report of the effects of compound *E* on rheumatic fever (Hench, Slocumb, Barnes, Smith, Polley and Kendall, *Proc. Staff Meet. Mayo Clinic*, **24**, 277; 1949). Since then, investigations have begun in centres of research in all parts of the world on the physiological action and the clinical application of cortisone. This work is now developing at an increasing rate, limited only by the availability of cortisone, the supply of which on the present scale is due to outstanding team-work in the research institution of a famous pharmaceutical firm.

Dr. Hench has long been a recognized authority on rheumatic diseases. After training in America, he obtained further experience in Freiburg im Breisgau and Munich, and joined the staff of the Mayo Clinic in 1923. The genesis of the discovery of the activity of cortisone is to be found in his belief that an endocrine influence was active in cases of remission of rheumatoid arthritis, for example, in pregnancy. The approach of Prof. Kendall to this subject has been along biochemical paths. He has worked at the Mayo Foundation since 1914 and his interests have been in the field of endocrinological chemistry. He was the first to isolate and investigate thyroxine. In 1930 he was president of the Association for the Study of Internal Secretions. His work on the chemistry of the adrenal cortex is described in a series of papers beginning in 1934, and the isolation of cortisone, then termed compound *E*, was announced in 1936. Prof. Reichstein elaborated a synthesis of ascorbic acid in 1933, almost simultaneously with the work of the late Sir Norman Haworth. His work on the isolation, determination of constitution and partial synthesis of constituents of the adrenal cortex began in 1935, when he was at the Eidgenossene Technische Hochschule in Zurich. The work continued uninterruptedly after transference to the Pharmaceutical Institute at the University of Basel in 1939 and was extended to other groups of steroid compounds, androstane and pregnane derivatives, and, by way of investigation of pharmacologically active plant constituents, to the cardiac glycosides; concurrently, investigations in carbohydrate chemistry were carried out. The scientific papers coming from Prof. Reichstein's laboratory during the past two decades form a remarkable record of technical and theoretical achievement in a field of complex chemistry.

Philosophy at Birmingham: Prof. L. J. Russell

PROF. L. J. RUSSELL, who recently retired from the chair of philosophy in the University of Birmingham (see *Nature*, August 16, p. 296), had a varied and influential career as a university teacher. He read both science and philosophy at Glasgow (which recently acknowledged his mature distinction by the award of an LL.D.) and he has never lost his interest in mathematical physics—an interest which determined the direction of much of his work, for example, both his historical investigations, which at one stage focused on Leibniz, and his numerous contributions to the discussion of scientific method. In the first flush of the triumph of the new symbolic logic he was able to mediate usefully between the old and the new, and did much to ensure that the new logical notations would be clear and distinct. More recently, his theory that some statements usually regarded as propositions are, in fact, 'proposals' has aroused international interest among logicians. Such more abstract discussions did not prevent him from taking a keen interest in the problems of contemporary society. He campaigned unwearyingly for a more concrete approach to ethics: philosophers, he contended, should not shirk the discussion of questions like birth-control, euthanasia, or pacifism. Here as elsewhere he had little patience with the 'standard works', and his quest for concreteness led him to make a wide study of social institutions and social anthropology. At Birmingham, one of his most successful innovations was a lively course on the logic of the social sciences. He never regarded himself as a mere 'Arts' man and his services were often sought in other faculties. A selection of his articles is to be published, the publication being sponsored by the University of Birmingham.

Perhaps the most many-sided of the professional philosophers of his generation, Russell was always informal and stimulating in his methods. His influence extended far beyond the limits of the schools of philosophy which were his immediate concern, and it always promoted freer thinking and wider horizons. Fortunately his retirement is due to no incapacity but solely to the passage of the years, and all who know him will expect his coming years to be marked by undiminished activity both in writing and in new fields of practical education.

Fifty Years of Service in Mineralogy: Dr. L. J. Spencer, C.B.E., F.R.S.

MEMBERS of the Mineralogical Society of Great Britain met in London on November 2 to do honour to Dr. L. J. Spencer, formerly keeper of minerals in the British Museum (Natural History). The occasion was the completion by Dr. Spencer of fifty years as editor of the *Mineralogical Magazine and Journal of the Mineralogical Society*, an honorary post which he has held since he took over the editorship from Sir Henry Miers in October 1900. The *Mineralogical Magazine* is issued quarterly and contains the Society's proceeding and papers read at its meetings. In 1920 the Society commenced publication of *Mineralogical Abstracts* as a separately paged part of the *Magazine*. The editor has contributed by far the greater number of all the abstracts published and has prepared topographical and subject indexes every three years. The next number of the *Magazine* will be a special one in his honour and will contain papers by distinguished mineralogists from many parts of the world. Dr. Spencer was eighty in July.

Indian Scientific Liaison Office in London: Dr. S. Krishna, C.I.E.

THE Government of India has appointed Dr. S. Krishna, lately vice-president of the Forest Research Institute, Dehra Dun, and director of forest products research, to be Indian scientific liaison officer in the United Kingdom. Dr. Krishna, who was born in 1896, was educated at the Forman Christian College (Lahore), Queen Mary College (London), and King's College (London). He held the professorship of chemistry, University of Punjab, during 1925–28, after which he entered Government service as biochemist at the Forest Research Institute, Dehra Dun. He was appointed C.I.E. in 1941. In 1948, he represented India at the Fifth Forestry Conference in London and in 1949 he visited Australia as leader of the Indian Science Delegation.

British Museum (Natural History)

IN the British Museum (Natural History) Mr. N. D. Riley, keeper of the Department of Entomology, has been appointed to be a deputy chief scientific officer, and Mr. A. W. Exell, principal scientific officer in the Department of Botany, to be deputy keeper in the Department. Mr. Riley entered the Entomological Section of the Department of Zoology in 1911, becoming keeper of the Department in 1932. He served in the Royal Army Service Corps during 1914–19 and was mentioned in dispatches. Mr. Riley has edited *The Entomologist* since 1922, and has been treasurer and later secretary of the Royal Entomological Society of London since 1939. He is a corresponding member of a number of foreign academies and scientific societies, and is the author of a large number of scientific papers, mainly dealing with butterflies from the systematic point of view. Mr. Exell entered the Museum in 1924, when he was placed in charge of the Polypetalæ. His main work has been on the flora of tropical Africa, and he made expeditions to the islands of the Gulf of Guinea during 1932–33 and in Angola in 1937. He was seconded to the Foreign Office during the Second World War.

United Nations Food and Agriculture Organisation

THE conference at Washington, D.C., of the sixty-three member nations of the United Nations Food and Agriculture Organisation, which began on November 4 and is expected to continue for a week, marks the last occasion on which the Organisation will meet at Washington before its move to new headquarters in Rome, scheduled to take place early next year. In Rome two new buildings will be occupied; these are under construction by the Italian Government, and the first is expected to be ready in February and the second in October. Mr. N. E. Dodd, the director-general of the Food and Agriculture Organisation, has stated that with the disruption of activities caused by the move and owing to the fact that a large proportion of the staff (about 80 per cent of the lower-salaried staff and 40 per cent of the higher grades) will not be going to Rome, the work of the Organisation will be severely hampered during the first half of 1951 at least. The conference at Washington, unlike the previous annual sessions, is a special one, limited to the essential financial and administrative matters and other urgent questions which may arise. This new departure was decided on at the 1949 conference when, in addition to the resolution for the transfer of the headquarters to Rome, the principle of biennial, rather than annual, conference sessions was also adopted; under this system a full-scale conference is not to be held until the autumn of 1951.

Development of Crawfish Industry in Tristan da Cunha

A PROJECT entailing the commercial development of the crawfish industry of Tristan da Cunha has been undertaken by the Colonial Development Corporation in conjunction with a South African fishery group. This will involve the operation of a fishery vessel, equipped with deep-freezing apparatus and deep cold-storage accommodation, to process and transport frozen crawfish tails to Capetown for regular shipment thence to the North American and European markets. In addition, a canning plant will be erected and operated on the Island itself. The Tristan da Cunha Development Co., which has undertaken the initial work of investigation, will now be re-organised, and additional finance to a total of £130,000 will be found by the Colonial Development Corporation, which will then have the financial control of the Company. The Company has also undertaken the responsibility of supplying both social and medical services to the islanders. Altogether this whole project may well be the deciding factor for the continuation of the settlement on the lonely island of Tristan da Cunha, where the community is in a difficult situation.

Eradicating Barberry in the United States

A RECENT bulletin of the U.S. Department of Agriculture ("Kill Barberry Bushes that Spread Stem Rust to Grains", Farmers' Bulletin No. 2014; April 1950) brings new methods to bear upon the time-honoured practice of controlling stem rust of cereals by destroying barberry. The use of the modern weed-killer 2,4-*D* is of particular interest; it is used at full strength to paint the stubs of European barberry canes immediately after the bushes have been cut off close to the ground. This method ensures that any other valuable plants growing in the vicinity will not suffer. Native barberries can be killed off with 2,4-*D* used as a foliage spray. Ammonium sulphamate is also used as a control, this substance being applied in dry form to all freshly cut surfaces, a pound being enough to kill several medium-sized bushes. Failing either of these chem-

icals, common salt will kill barberry if applied to the crowns of European plants in sufficient quantity (about 20 lb. per square foot of crown). Native bushes will succumb if the salt is merely sprinkled lightly on the ground around the canes.

National Certificates in Applied Physics

A PAMPHLET recently issued by the Institute of Physics describes the purpose, scope and value of the courses leading to the award of national certificates in applied physics. It is pointed out that every professional physicist employed in research and development requires two or three technical assistants who need to have a knowledge of the fundamentals of physics and some skill in experimental technique and in making apparatus and instruments. It is for these assistants that the certificates are intended. They are awarded jointly by the Ministry of Education and the Institute of Physics. Study is part-time, extending for the ordinary certificate over three years, and for the higher certificate over a further two years of advanced study, and reaching a standard approximating to that of a university degree at pass standard in the subject. Students attend at recognized technical colleges. The examinations on which the certificates are awarded are assessed by senior members of the profession appointed by the Institute of Physics. Copies of examination papers set in recent examinations are now available and may be obtained from the Institute of Physics, 47 Belgrave Square, London, S.W.1.

University of London

THE following have been appointed to University of London readerships tenable at University College in the subjects indicated: Mr. Michael Abercrombie, embryology; Dr. E. H. S. Burhop, physics; Mr. J. W. Whitfield, psychology. The degree of D.Sc. has been conferred on the following: B. Kassanis (Rothamsted Experimental Station), Dr. H. O. Schild (University College), R. Kingslake (Imperial College of Science and Technology), E. C. Humphries (Queen Mary College), J. J. D. King (King's College Hospital Medical School), and C. N. Davies (external student).

University of Leeds

THE following gifts, among others, have been received by the University of Leeds: sums not exceeding £4,000 in 1950–51 and £5,000 in 1951–52, from the University Grants Committee, for financial assistance to students taking postgraduate courses in the Departments of Fuel and of Textile Industries; £12,000 (approximately) over three years from the Department of Scientific and Industrial Research to the Department of Botany for research in plant biophysics; £6,000 (approximately) over three years from the Agricultural Research Council to the Department of Botany for new biochemical research; £1,000 from the North-Eastern Division of the National Coal Board to the Department of Mining; an annual sum of £2,000 (less tax) for fifteen years from the Worshipful Company of Clothworkers, for the maintenance or benefit of the Clothworkers' Departments; and a renewal by Imperial Chemical Industries, Ltd., of the covenant for the endowment of fellowships for a further seven years, the value of the fellowships to be increased from £600 to £800 a year. Dr. J. H. Western has been appointed senior lecturer in agricultural botany in the University, and the following have been made lecturers in the subjects as indicated: A. D. Greenwood (botany), Dr. L. Peters (textile industries), Dr. A. Jowett (dressing of minerals, in the Department of Mining) and Dr. D. E. Nicholson (bacteriology).

Announcements

THE Committee of the Privy Council for Agricultural Research and Nature Conservation has appointed Dr. Norman C. Wright, chief scientific adviser of the Ministry of Food, to be a member of the Agricultural Research Council.

PROF. F. A. VICK, professor of physics, has been appointed vice-principal of the University College of North Staffordshire. The following have been made lecturers in the College: Dr. R. G. Evans (biology) and Dr. P. H. Plesch (chemistry).

LORD REITH has been appointed chairman of the Colonial Development Corporation in succession to Lord Trefgarne, whose resignation took effect on October 31.

MR. D. W. Bishopp, director of the Geological Survey of Ireland since 1940, has resigned. He has now been appointed senior geologist to the Cyprus Government, which is initiating a detailed geological and mineralogical survey, including geophysical research, of the island.

THE gold medal of the Society of Dyers and Colourists has been awarded to Dr. S. M. Neale, senior lecturer in physical chemistry in the College of Technology, Manchester. The award was made "For pioneer work in the application of the methods of physical chemistry to the elucidation of the phenomena of dyeing, more particularly of cellulosic materials with substantive dyes".

THE first British Instrument Industries' Exhibition will be held in the National Hall, Olympia, during July 4–14, 1951. Coinciding with the Festival of Britain year, this Exhibition will show scientific and industrial instruments of entirely British manufacture and is designed to increase the export market. Further details can be obtained from the organisers, Messrs. F. W. Bridges and Sons, Ltd., Grand Buildings, Trafalgar Square, London, W.C.2.

THE nineteenth Stephen Paget Memorial Lecture of the Research Defence Society will be delivered by Prof. E. D. Adrian on November 22, at 5.30 p.m., at University College, Gower Street, London, W.C.1. Prof. Adrian will speak on "Experiments on the Nervous System".

THE first Trotter-Patterson Memorial Lecture of the Illuminating Engineering Society is to be given by Dr. J. W. T. Walsh, of the National Physical Laboratory, at the Royal Institution, Albemarle Street, London, W.1, on January 17, at 6 p.m. Dr. Walsh will speak on "The Early Years of Illuminating Engineering in Great Britain". The Lecture is open to the public and admission will be by ticket, obtainable from the Secretary, Illuminating Engineering Society, 32 Victoria Street, London, S.W.1.

IN the last paragraph of the review, published in *Nature* of October 14, p. 620, of Corner's "A Monograph of *Clavaria* and Allied Genera", the comment that only one specimen of a clavaroid fungus has been sent to the Kew Herbarium in the past thirty years is incorrect; for 'Kew' read 'Commonwealth Mycological Institute'. In fact, Kew Herbarium, where the group has been studied, has numerous examples of *Clavaria*.

INTELLIGIBILITY OF EDUCATIONAL BROADCASTS*

A B.B.C. experiment in further education, initiated two years ago, included an attempt to trace some of the educational effects of broadcasts to adults. A first step was clearly to ascertain whether, in fact, broadcast speakers were being understood by their audiences. Early in 1949 Prof. P. E. Vernon, professor of educational psychology in the University of London Institute of Education, was consulted about the possibilities of measuring the intelligibility of sample broadcasts and also identifying the qualities of a script which make it easy or difficult to understand. A scheme of investigation was drawn up and, with the co-operation of the Army Institute of Education, it was decided to study fifty Forces Educational Broadcasts. At the same time the present writer carried out parallel experiments with a number of broadcasts, including three on the subject of science, constructed at different levels of difficulty.

American investigators—Lorge, Flesch, Dale and Chall—have attempted to produce formulæ by which one could predict the intelligibility of written or spoken material by measuring the strength of such factors as difficulty of vocabulary, complexity of words, personal references and length of sentences. Prof. and Mrs. Vernon's experiments included assessments of these and other qualities up to a total of thirty-five different factors, which were thought by the investigators or by B.B.C. talks producers to be important.

Objective qualities in the scripts were measured by taking sample passages of 500 words and counting numbers of active verbs, concrete nouns, prepositions, references to numbers, etc. Other qualities in the talks such as number of teaching points, concreteness, lucidity, good or poor delivery by the speaker, could only be assessed by having B.B.C. talks producers and the investigators rate them independently, and taking their combined judgments.

Most of the 4,600 listeners taking part in the investigation were soldiers in Home Commands who were listening as part of their normal educational activities. An average of 92 subjects per broadcast, representing the full range of intelligence and education, completed the test papers. The responses took the form of: (*a*) five-point ratings recording easiness or difficulty of understanding the broadcast; (*b*) similar ratings of interest; and (*c*) attempts to reproduce in the listener's own words the main points of the talk.

Listeners' reproductions were marked against a scale of up to six teaching points drawn up by the investigators. A borderline of 3 marks out of 12 was taken as the point below which the listener evidently quite misunderstood or failed to make much sense of the talk. Supplementary experiments showed that this was a fair and reliable method of testing comprehension, for although interviews with subjects, and 'prodding' with questions about particular points in a talk, produced rather more material than written recall, the relative scores of groups of listeners subjected to both methods remained much the same for different broadcasts.

For the average broadcast—and the Forces broadcasts are among the simplest in the B.B.C.'s output—the following proportions of the four intelligence and educational groups fell below the borderline of 3 marks, that is, were unable to grasp the gist of the talks:

% of population	Intelligence/Educational group	% below borderline
10	School certificate or above	8
20	Above average intelligence	29
40	Average elementary school	56
30	Backward	82

The correlation between intelligibility scores and education plus intelligence level is very high, +0·62, showing the need to adapt the level of a talk to the level of the audience. If one leaves out of account the backward, sub-literate 30 per cent of the population, for whom the educational talk is probably an unsuitable approach, roughly half the remaining samples understood even the more difficult series such as "Plain English", and the better "Current Affairs" and "Science" talks were comprehended by about three-quarters of these average and superior groups.

Prof. Vernon's analysis of the qualities making for intelligibility showed that by far the most important factor, apart from the intelligence and educational level of the listener, is the degree of interest in the content of the talk. Between intelligibility scores and listeners' judgments of interest the correlation varies from 0·47 for the higher educational levels to 0·64 for the lower. So strong is the interest factor that many of the talks on science and current affairs which bore all the marks of difficulty (for example, a large number of teaching points, many difficult words, complexity of style), but which dealt with an interesting topic, were actually comprehended better than other talks which had the simplest of constructions and were sometimes dramatized, but proved rather boring to their listeners.

When the interest factor is held constant, the importance of some of the stylistic features emerges. Factors reducing understanding are: an excess of major points, overlong sentences, numerous difficult words, abstract nouns, prepositional clauses, metaphors and figures of speech, and over-rapid delivery. Factors making for understanding are: a lucid or lively style, a clear summary at the end of a talk, concreteness of treatment as well as of subject-matter and illustration of an abstract point so long as it is directly and obviously linked to the point. Nevertheless, a talk is a whole which is more than the sum of all these parts: and a competent speaker, dealing with an interesting subject, can make himself understood even if he breaks most of the rules of which Flesch and the American readability experts would approve.

Mr. Joseph Trenaman (assistant further education officer, B.B.C.) said he has been able to measure, on the basis of tests of only a few talks, as well as immediate recall, something of the wider effectiveness of broadcasts, for example, memory of content and changes in interest after a lapse of time, and application of the information given in a broadcast to new situations. Listening has also been compared

* Substance of papers read before Section J (Psychology) of the British Association at Birmingham on September 5 by Prof. P. E. Vernon, Mrs. D. F. Vernon and Mr. J. Trenaman.

with reading as a mode of presentation, all the tests on two broadcasts being carried out with matched pairs of groups, one listening and the other reading the script of the broadcast. The samples, numbering 912 for the three programmes on science, were drawn from three educational levels—sixth forms of grammar schools, second-year technical students, and non-vocational students (ex-modern schools) released by their employers for further education.

The responses were marked against a scoring key which was obtained by combining the assessments of a number of science teachers and education officials of the important points of the script. As many as 37 points were thus recorded, and marks of from 1 to 5 allotted according to the emphasis and agreement of the assessors. After the reproductions had been marked, samples of the several scores from 0 to more than 40 for each broadcast were arranged in random order and sent, without any marks attached, to five science teachers who were asked, after studying the original script, to sort them into those which showed at least sufficient understanding of one of the important points of the broadcast and those which did not. The results showed close agreement, and borderlines were fixed accordingly, from 15 to 30 per cent up the scale of marks. They were lowered slightly to allow for additional points brought out by listeners in applying the ideas of the broadcasts to new situations.

The most difficult of the three talks was one given by a distinguished physicist on electronics. It was intended for the general public, and the speaker had been at great pains to make it simple. It proved intelligible to about two-thirds of the grammar school listeners, but only to small minorities below that level, and could not have been understood by more than 10 per cent of the adult population. The second broadcast, a Forces educational talk on sources of energy, was understood by about half the sample population, with much the same distribution as that given in Prof. Vernon's table. The third broadcast, also on a source of energy, was a dramatized programme originally put out for fourteen-year-old 'modern school' children. This was comprehended by nearly two-thirds of the sample groups. Dramatized stories from this broadcast, in the same way as vivid images, were very frequently reproduced, and were more easily retained, as was shown in the reproduction of such items on delayed recall. But, as Prof. Vernon found, quite often the point which the story was intended to illustrate was lost in the process.

Listeners were asked to rate their interest in the broadcasts. The differences between ratings made immediately after listening and those made a week later were striking. On average they fell by as much as one-third of the normal range of such ratings. The loss was particularly great in the case of grammar school listeners, who heard the dramatized programme for secondary 'modern' children; many of them found it very interesting at the time but on retrospect they thought it childish or slow. Taking average scores for whole samples, it was found that the more interesting talk proved also to be the more widely understood. Yet within the audience to any one of the broadcasts an entirely different relationship appeared. At the three educational levels the two factors vary inversely; thus, grammar school listeners understood the broadcasts most widely but were least interested; 'modern school' types understood them least and were most interested. As between individual listeners, the regression of understanding on interest is curvilinear. Great enthusiasm usually accompanies imperfect understanding, and with less enthusiasm there is increasing understanding, until below the median the two factors diminish in equal ratio. So, although interest is the most powerful factor making for intelligibility, of which average interest ratings may be taken as a rough-and-ready index, the same correlation is found neither between individuals nor between educational levels.

Each of these three science broadcasts achieved its greatest effect at a different educational level. The talk by the physicist was most enjoyed at the grammar school level; the Forces educational talk at technical student level; and the schools programme at 'modern school' level. In each case the educational group which most enjoyed the broadcast found it just, but only just, within its grasp (that is, about two-thirds of the group obtained scores above the borderline). Since limits of understanding vary so widely throughout the population, and since what is found interesting by one educational level is not acceptable to others, it would seem to follow that scientific material must be communicated at several different levels of difficulty if it is to be generally intelligible.

The parallel tests of reading and listening to the three science broadcasts showed that it made no significant difference whether that material was communicated through the written or the spoken word; both were equally effective on immediate impact, after a lapse of time, and in application of the ideas to new situations. J. TRENAMAN

BIOCHEMICAL AND BIOLOGICAL EFFECTS OF DIETHANOLAMINE

Glycogen and Lipid Content of the Liver of Mice receiving Simple Alkanolamines

THE intraperitoneal administration of diethanolamine over a period of time to white laboratory mice kept on a stock diet (percentage composition: corn flour, 75; casein, 8; meat powder, 6; fat, 3; peanut oil, 6; cod liver oil, 1; and salt mixture, 0·3) led to an increase in the glycogen content of the liver and to a decrease in its total lipid content. The water content of the liver was also increased. At the same time the weight and size of the liver of the animals became enlarged.

The physiological action of monoethanolamine and triethanolamine seemed to be simpler and, within the limits of our experiments, led only to an increase in the water content and to a decrease in the total lipids of the liver of the mouse. The glycogen content seemed to be unaltered.

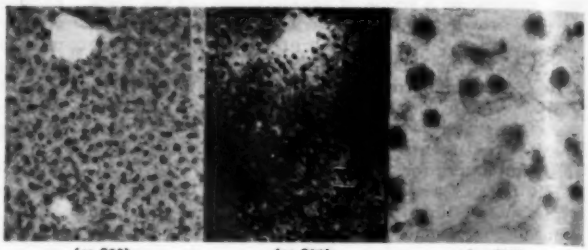
It is suggested that the biological reaction of diethanolamine is a complicated one, and that different cell constituents may be involved.

Eperjessy and Zathureczky[1] reported that in a Warburg experiment some aliphatic amines—especially alkanolamines—decrease the respiratory quotient of the surviving liver tissue of the rat. They concluded that alkanolamines speed up the metabolism of the lipids in the liver. Artom *et al.*[2] found in the liver of rats maintained on low protein diets that the administration of a single large dose of either diethanolamine or ethanolamine stimulated lipid phosphorylation.

They also found a drop in the total lipids in the liver of rats maintained on similar diets for twelve days and supplemented with diethanolamine.

As a rule, an injection period of three days gave the required effect. The last injection was given at 9 a.m. on the day of the experiment. Food was withheld, but water was given *ad libitum*. After a starvation period of five hours, the animals were decapitated and their livers removed and weighed. In each case the same parts of liver were used for the lipid and glycogen analysis.

Liver glycogen was determined by the method of Hood and Kramer *et al.*[2]. For the quantitative determination of lipids in the liver we used the method of Bloor[4].



(× 200) Control (× 200) (× 600)

Fig. 1. Liver tissue after intraperitoneal injection of 12·4 mgm. diethanolamine for 3 days

No. of expt.	Substance	Days of treatment and amount of substance (mgm.)	Body weight (gm.)	Liver weight (mgm.)	% of water	% of sugar	% of lipid
1	Diethanolamine	2/6	28·4	1,314	70·5	1·2	
	Control		31·4	1,141	69·0	0·4	
2	Diethanolamine	2/12	25·2	1,445	66·4	1·5	22·4
	Control		26·3	1,158	65·5	0·4	24·4
3	Diethanolamine	3/12	29·0	1,430	69·7	1·7	
	Control		30·8	1,084	67·2	0·3	
4	Diethanolamine	5/6	25·6	1,184	72·9	4·7	23·0
	Control		26·0	1,032	69·2	0·5	27·5
5	Diethanolamine	30/12	29·2	1,551	72·5	2·2	20·7
	Control		30·3	1,138	69·8	0·9	23·8
6	Diethanolamine	48/8	26·3	1,446	70·4	1·9	19·7
	Control		27·0	1,030	69·0	0·4	27·3

Diethanolamine was used in the form of its hydrochloride-salt. Maximal quantities injected were 0·4 ml. Body-weight means weight of dead animal without liver. All values of sugar and lipids are related to the dry weight of the liver.

The results are shown in the accompanying table.

E. Annau
A. Manginelli
A. Roth

[1] Annau, E., Eperjessy, A., Mihályi, E., and Zathureczky, Z., *Z. phys. Chem.*, **282**, 69 (1947).

[2] Artom, C., Cornatzer, W. E., and Crowder, M., *J. Biol. Chem.*, **180**, 495 (1949).

[3] Hood, H. A., Kramer, H., Somogyi and Mitchell, *J. Biol. Chem.*, **100**, 458 (1933).

[4] Bloor, W. R., "Biochemistry of the Fatty Acids" (1943).

Alkaline Phosphatase Activity and Nuclear Changes in the Liver induced by Diethanolamine

THE experiments described in the previous communication showed that prolonged administration of diethanolamine to white laboratory mice produced an increase in the glycogen content of the liver and a decrease in the content of total lipids. At the same time the weight and size of the liver of the test animals became enlarged.

Artom *et al.*[1] showed that the administration of diethanolamine in a single large dose leads to an increased phosphorylation of the lipids in the liver of rats. As a consequence, it was suggested that the increased lipid metabolism, that is, phosphorylation, may be connected with phosphatase activity.

Chemical examinations showed that diethanolamine administration for at least three days induces a significant increase of the alkaline phosphatase of the mouse liver. Acid phosphatase seemed to be unaltered.

For the quantitative evaluation of the phosphatase activity of the mouse liver we used the method of J. P. Greenstein[3], in which homogenized liver tissue is suspended in distilled water (1 : 10) and extracted for twenty-four hours in the cold. Sodium-glycerophosphate (Merck) served as substrate. Phosphorus was determined by the method of Fiske and Subba Row[3] (see table).

No. of expt.	Substance (mgm.)	Days of treatment	Phosphorus (mgm.)	Phosphorus in controls (mgm.)
1	Diethanolamine, 12·4	3	0·0033	0·0014
2	,,	,,	0·0035	0·0008
3	,,	,,	0·0032	0·0016
4	,,	,,	0·0018	0·0012
5	,,	6	0·0019	0·0008
6	,,	,,	0·0022	0·0011
7	,,	,,	0·0056	0·0014
8	,,	,,	0·0027	0·0014

Sodium-glycerophosphate (Merck) 2 per cent, 0·5 ml.; veronal-buffer pH 8·8, 5 ml.; enzyme solution, 1 ml.; distilled water, 2·5 ml. Time of incubation, 1 hour.

Histochemical phosphatase investigations by G. Gomori's method showed also a well-defined increase in alkaline phosphatase in the liver tissue (Fig. 1). The observations seem to suggest that diethanolamine induces increased production, at first in the nucleolus, of alkaline phosphatase, which eventually fills up the

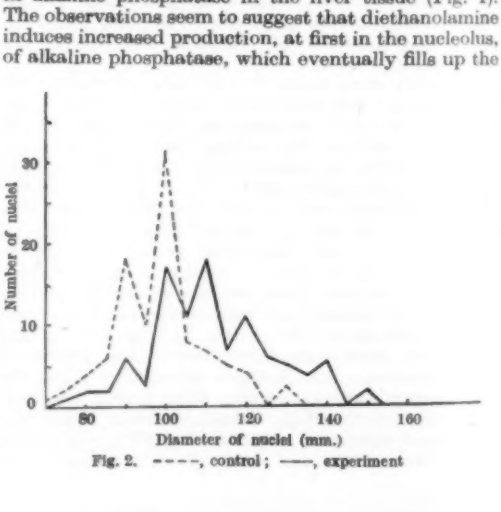


Fig. 2. ----, control; ——, experiment

whole of the nucleus, whence it diffuses out into the cytoplasm.

Measurements of the size of cell nuclei of mouse liver showed that diethanolamine administration increases their size; that is, the number of small and medium-sized nuclei diminish and large nuclei appear in a greater quantity (Fig. 2). No mitoses could be detected in the cells of the enlarged livers.

It is suggested that the action of diethanolamine on mouse liver may manifest itself to a large extent in a change of the phospholipid pattern of the cell nuclei. This view is supported by the observations of Artom *et al.*, who showed that by prolonged administration of diethanolamine, choline is partly replaced in the lecithins by diethanolamine, and by the work of H. H. Williams *et al.*[4], who concluded from their experiments carried out on rat hepatoma, produced by feeding butter-yellow, that "the pathological derangement of the phospholipid content of the liver cell occurs primarily in the nucleus".

We are indebted to A. Fajer for carrying out the analytical work.

E. Annau
A. Manginelli

Fundação Andréa e Virginia Matarazzo,
Faculdade de Medicina,
Universidade de São Paulo. May 11.

[1] Artom, C., Cornatzer, W. E., and Crowder, M., *J. Biol. Chem.*, **180**, 495 (1949).
[2] Greenstein, J. P., *J. Nat. Cancer Inst.*, **2**, 551 (1942).
[3] Fiske and Subba Row, *J. Biol. Chem.*, **66**, 375 (1925).
[4] Williams, H. H., Kaucher, M., Richards, A. J., Moyer, E. Z., and Sharpless, G. R. J., *J. Biol. Chem.*, **160**, 227 (1945).

APPLICATIONS OF ISOTOPES IN SCIENTIFIC RESEARCH

A CONFERENCE on the "Applications of Isotopes in Scientific Research" took place in the University of Melbourne during August 14–17 under the auspices of the Chemistry Department of the University and the Commonwealth Scientific and Industrial Research Organization. The eighteen papers presented fell roughly into two main groups: those of a general character dealing with methods of assay, health hazards and limitations of the use of isotopes; and papers that were essentially reports of work in progress.

F. K. McTaggart and I. E. Newnham illustrated the use of zirconium-95 and hafnium-181 as tracers in the study of chemical methods of separating the elements zirconium and hafnium, and presented some new solubility data for the salts of these two metals. Physico-chemical limitations of the tracer technique were considered by Dr. G. M. Harris. In a discussion of the exchange of carbonate ion (containing carbon-14) with carbonato-tetrammine cobaltic ion, it was pointed out that any attempt to describe quantitatively the kinetics of the reaction must take into account the isotope effect.

Many instances of variations in the relative abundance of stable isotopes of the lighter elements have been observed. In his paper on the assay of stable isotopes, Dr. J. D. Morrison added to the list of such variations that of the carbon-12/carbon-13 ratio (from 88 to 93) in Australian natural graphites.

By means of numerous radioautographs C. R. Millikan illustrated the use of manganese-54 to study the distribution of manganese in diseased and healthy plants. Anisotropy of the rate of the self-diffusion of tin in tetragonal single crystals of high purity, disclosed by the use of tin-113 as tracer, was reported by Dr. W. Boas and P. J. Fensham. In polycrystalline tin it was found that the rate of diffusion along grain boundaries is generally considerably higher than that of volume diffusion except when the boundary is that between crystals of similar orientations or between twins. The effects of structural factors and solvent on the ability of internal cobalt (II) complexes to exchange with cobalt II ions were considered by B. O. West in a paper on "Exchange Reactions and Problems of Chemical Structure".

Illustrating entomological applications of radioactive tracers, Dr. M. F. Day outlined experiments in which methionine containing radiosulphur was fed to clothes moth larvæ. A wide difference between the mechanism of sulphur metabolism in this insect and in some other species is indicated. The results of investigations of the mechanism of reactions in liquid sulphur dioxide by the use of oxygen-18 were discussed by Dr. I. Lauder. Difficulties encountered in the synthesis of isotopic molecules containing deuterium were fully illustrated in F. I. Andersen's account of the preparation of monodeuterio methyl bromide.

Other papers read at the conference were concerned with the fundamentals of nuclear physics (Dr. J. C. Bower), statistics of radioactivity (E. A. Cornish), assay of radioisotopes (Dr. T. H. Oddie), applications of nuclear emulsions (Dr. V. D. Hopper), tracer method limitations in biology (Dr. W. P. Rogers), health and safety precautions (D. J. Stevens), attempts to concentrate potassium-40 (Dr. G. A. Elliott), assay of radioactive minerals (J. Daly), and general problems in the synthesis of labelled molecules (A. M. Downes). It is hoped that the full report will be available at an early date.

D. P. Mellor

NATURAL PRODUCTS OF THE BRITISH COLONIES

TWO NEW JOURNALS

THE functions of the Imperial Institute, at Exhibition Road, London, S.W.7, have recently been reorganised, and two of its former Departments—Mineral Resources, and Plant and Animal Products—have now become, respectively, the Mineral Resources Division of the Colonial Geological Survey, and the Colonial Products Advisory Bureau. Previously, the work of these two Departments was published in the *Bulletin of the Imperial Institute*; the *Bulletin* is now replaced by two separate quarterly journals: *Colonial Plant and Animal Products*[1], and *Colonial Geology and Mineral Resources*[2].

The issue of the first number of the former periodical is of particular significance at the present time when the public conscience has awakened to the pressing needs of the Colonies. As the former Secretary of State for the Colonies, Mr. A. Creech Jones, states in a foreword, the resources of the dependent territories are of increasing importance both to the inhabitants themselves, who demand a higher standard of living, and to the whole of the sterling area. Much was done in the years between the two World Wars and also, let it not be forgotten, in the period before the First World War, to assess the economic potentialities of these territories. But

during that time the workers were all too few, and with the best will in the world they could touch only the fringe of the work. As is well known, the aftermath of the Second World War has led to profound changes, not only territorially but also financially, due to difficulties that have arisen through currency restrictions. Inevitably attention in Great Britain has been directed to the vast and largely unassessed potentialities of the Colonies, which, being within the sterling area, afford wonderful opportunities for mutual trade to the benefit of both the mother country and the dependencies.

Previously much of this work was carried on by the Imperial Institute and other bodies working independently, and the former *Bulletin* of the Institute was regarded by most scientific workers in the tropics as a valuable work of reference on natural products. As regards the agricultural research work done at the Imperial Institute laboratories, this was valuable to investigators in the tropics, as it helped them to assess the commercial possibilities of products arising from little-known plants. With the assistance so provided, the worker in the Colonies was able to guide his further researches, if the prospects seemed good, for the development of a profitable market, or to turn his attention to more profitable lines of work if the reports should be unfavourable. A reference to files of agricultural departmental reports will provide numerous examples of the work done in this connexion. The assessment of new types of oil from little-known plants is one example; another is the evaluation of different kinds of fibre obtained from plants that were not hitherto considered to have commercial potentialities; and a third concerns plants of medicinal value. For example, the establishment of the tung oil industry in countries such as Nyasaland, and the development of jute fibre substitutes such as ramie and hibiscus owe much to the pioneer work of the Institute.

Now, with the pressing needs of the times, all this work has, of necessity, been brought under the central direction of the Colonial Products Advisory Bureau, and *Colonial Plant and Animal Products* indicates that the continuity of these investigations is assured under the new organisation. The first issue reports, for example, on two little-known oil seeds, namely, *Lippia carviodora* from Kenya, and *Hibiscus esculentis*, which was always regarded hitherto as a somewhat uninspiring vegetable. Reports on manila hemp in Borneo, and the suitability of banana trash for paper-making, carry on the traditions of the old Fibre Section, and a note on wormseed (*Santonica*) continues the pharmaceutical tradition. There are three original articles: sugar cane processing; the insect fauna of *Lonchocarpus* and derris (for, curiously enough, these insecticidal plants are themselves subject to attack by various beetles when their dried roots are in storage); and a note on the preparation of silk gut.

Finally, one is glad to see that the bibliography for agricultural and forestry subjects is continued, as it adds greatly to the value of the journal. Under its new form it is believed that this publication will help to stimulate still further the interest of all interested in Colonial development.

The purpose of the other new journal, *Colonial Geology and Mineral Resources*, is to record the progress that is being made in the geological investigation of the various territories comprising the Colonial Empire and to provide information of current developments in mineral resources, mining and mineral economics. The first number appropriately contains an authoritative account, by Dr. F. Dixey, of the scope and work of the Directorate of the Colonial Geological Surveys. The primary purpose of the Surveys is the preparation of a basic geological map of the Colonial Empire to serve as the foundation for a thorough investigation of mineral resources. Since the time when the Directorate was established in January 1947, many of the old Surveys have been expanded and plans for new ones have been approved, the territories in which work is now actively in progress being Uganda, Kenya, Tanganyika, Northern Rhodesia, Nyasaland, Bechuanaland, Swaziland, Nigeria, Gold Coast, Sierra Leone, Malaya, Sarawak and North Borneo, Fiji, British Guiana, Jamaica and Cyprus. The overseas and London staffs numbered 111 and 25, respectively, in April 1950 and are expected to reach 160 and 45 by the end of next year.

The journal provides "a convenient forum for the expression of responsible geological thought and opinion" and its contributors are not to be limited to members of staff. The present issue, for example, contains a most valuable article by H. R. Hose, of Aluminium Laboratories, Ltd., on "The Geology and Mineral Resources of Jamaica", accompanied by specially prepared geological and mineral maps. A permanent feature of the journal is to be a series of reports of recent progress, contributed by the Surveys themselves. The first batch of eight clearly indicates that for this feature alone the new journal will be widely welcomed. Other sections are devoted to notes on special activities and conferences, discoveries of significance and abstracts of publications; book reviews; bibliography; personalia; and mineral and metal prices.

The Directorate and the editor, Mr. E. H. Beard (vice-principal of the Mineral Resources Division), are to be congratulated on their enterprise in producing an attractive, authoritative and inexpensive journal which adequately meets a real need and which, apart from its wide appeal to mining engineers, economists and industrialists, will undoubtedly be highly appreciated by geologists, not only in Great Britain and the British Colonies but also throughout the world.

[1] *Colonial Plant and Animal Products*, 1, No. 1 (1950). (London: H.M. Stationery Office.) 5*s*. net.

[2] *Colonial Geology and Mineral Resources*: The Quarterly Bulletin of the Colonial Geological Surveys, 1, No. 1 (1950). Pp. 120. (London: H.M. Stationery Office.) 5*s*. net.

THE IMPERIAL FORESTRY INSTITUTE, OXFORD

ON October 19, H.R.H. Princess Margaret, in the presence of a large and distinguished gathering, opened the new building of the Department of Forestry of the University of Oxford, on a site in South Parks Road between the Physical Chemistry and Pathology Departments. The Imperial Forestry Institute was founded in 1924 as the outcome of recommendations of the Empire Forestry Conferences of 1920 and 1923, to provide an Empire centre for higher education and research, to be jointly financed by the governments interested and linked with the already existing University School of Forestry. The School owed its origin to arrangements made in 1905 between the University of Oxford and the India Office for the training of probationers for the Indian

Forest Service at Oxford after the Royal Indian Engineering College at Coopers Hill (near Windsor) had closed down. From the start, the need for an adequate building for the new venture was recognized; but, at the time, the necessary money could not be found. Temporary accommodation was secured where it could be obtained, and the staff now accommodated under one roof has been gathered in from four buildings in as many streets. The fine new four-storied building in Bladon and Clipsham stone has been constructed with funds from various sources, beginning with generous gifts from the Rajah of Sarawak, the Rhodes Trust and the Pilgrim Trust; a large contribution was made from the Colonial Development and Welfare Fund, and the University has borne the large increase in building costs since the plan and estimates were approved in 1945.

The new Institute accommodates the old School and Institute, which are now combined to form the Department of Forestry (the 'Imperial Forestry Institute' is the statutory designation of the building in which it works), and also the Commonwealth Forestry Bureau, an organization that is entirely independent financially and administratively but otherwise dependent on the Library of the Institute for its functioning as the central information service on forestry for the Commonwealth. The teaching activities continue to cover both undergraduate and postgraduate courses as well as training in research. All probationary officers of the Colonial Forest Service take a postgraduate course after a tour of duty in the Colonies, and under a special arrangement with the Governments of India and Pakistan some of the junior officers of their forest services go to the Institute for a similar course planned to meet their special requirements. There are usually some forest service officers on study leave and other foresters undertaking special studies or actual research work from the Colonies and Dominions and occasionally from foreign countries.

Practically every timber-producing part of the Commonwealth has contributed timber to the building, a suggestion that such gifts would be welcome having met with a most generous response from governments and timber-trade organizations. Eleven of the rooms have been panelled with different timbers thus received, and fourteen kinds of timber have been used for flooring blocks. The furniture has been constructed from nearly thirty different woods, and more than a dozen have been used for general furnishing for shelving, bench tops, cupboards, seating, etc. The doors form an exceptionally fine display of home-grown and imported timbers, twenty-four species being represented, all of them available on the open market. It will be apparent that the building has many unique features, and as one speaker described it, "it is worthy of forestry and worthy of Oxford".

In all, the School has nearly a hundred rooms, including three lecture rooms, three teaching laboratories and three other rooms suitable for small classes so that four courses can be run simultaneously when required. The main sections provide for work on sylviculture, pathology, wood structure, engineering, economics, systematic botany, entomology, mensuration, management, physiology, ecology and microbiology. There are also seven small research rooms.

The Library, with connected activities, occupies the whole of the front of the first floor. It claims to be the most complete of its kind, aiming at world cover in forestry proper. It contains about 4,500 bound books and some 25,000 pamphlets, etc., while the periodicals comprise more than three hundred series in twenty-one languages, and the collection of forest administration reports is nowhere paralleled. The Forestry Bureau occupies rooms immediately adjoining the Library and deals with all literature received directly it has been registered; it provides the reference slips for the card indexes which now contain about 200,000 cards and are growing at the rate of 16,000 yearly.

Common services include well-equipped workshops for both wood- and metal-work, photographic and artists' sections, two balance rooms, a computing room, and a low-temperature room. The photographic collection contains about 8,000 prints and 3,000 lantern slides.

The Forest Herbarium of the old Institute has been transferred to the Department of Botany and will be housed in its new building, which is now approaching completion and will be linked with the Forestry Department by a common lecture theatre. The wood collection includes about 17,000 specimens and a very large number of microscopic slides, British Colonial species being most strongly represented.

The opening ceremony began in the Milner Hall of Rhodes House, close to the new building, with an address of welcome by Prof. H. G. Champion and a speech by Princess Margaret, in the course of which she referred to the importance and efficacy of afforestation in checking soil erosion, as she had herself seen in South Africa, and to the record of achievement of forestry in India. She also pointed out that "the responsibilities of the forester do not stop at the scientific and commercial aspects of timber production. It falls to him to make our woods and forests as lovely as possible so that we may all enjoy them. . . . This calls for a close understanding between forester, farmer, sportsman and, indeed, all those who love the country." In a few felicitous phrases, the Vice-Chancellor thanked Princess Margaret, suggesting that the most satisfying experience life can afford is for one's work to have to do with things that are both beautiful and useful, as are trees.

The Royal party then walked in procession to the Institute, where the Princess planted a yew tree, chosen as an appropriate symbol of longevity and durability, and she formally unlocked the doors. She was conducted through the chief rooms and saw an exhibition staged to demonstrate the ways in which forests and forestry contribute to general welfare, and to illustrate the various fields in which research is in progress. On leaving, she spoke to the workmen who had been engaged in the building work, some of them for the whole five years it has been in progress. The three hundred guests, who included representatives of the governments and forest departments of most of the Dominions and Colonies as well as several foreign countries, afterwards saw the main exhibition and also the ten sectional exhibits of a more specialized character. On the following day, about 250 persons connected with the University visited the new Institute, and on the third day about 450 of the general public.

The University of Oxford at last has a worthy building for its forestry work, and the contributing countries of the Commonwealth a well-equipped centre for advanced study. The only cloud on the horizon is a measure of insecurity as regards future financial provision for the maintenance of its activities.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Is Parthenogenesis Sexual or Asexual Reproduction?

CYTOLOGISTS and others commonly refer to parthenogenesis as asexual reproduction. This usage is, for example, to be found in the books of Wilson[1], Darlington[2], and White[3], along with the facts that indicate that parthenogenesis is a derivative of normal sexual reproduction. To an elementary student of these phenomena, parthenogenesis appears to have much more in common with other types of sexual reproduction, and to refer it to asexual reproduction puts it in the same general category as budding and fission, to which parthenogenesis has little or no significant resemblance. The fact that parthenogenetic eggs develop without fertilization is no doubt responsible for this usage, a fact which, however, need not carry the entire weight of the decision as between sexual and asexual reproduction. True enough the biological significance of sexual reproduction is in part dependent upon fertilization; but most of this significance also relates to cross-fertilization, which is by no means co-extensive with sexual reproduction.

Sexual reproduction should not be diagnosed entirely upon the basis of what happens to an egg *after* it is formed. There has been a long biological history behind the development and perfection of mechanisms and processes which have made it possible to produce any kind of egg at all. In fact, an egg is a gamete, produced most commonly in a specialized female gonad. During its production complex gametogenetic processes of great significance normally take place, though some of these may be secondarily reduced in such a way as to secure the advantage of the normal efficiency of sexual reproduction without requiring the union with a sperm for activation. Whether parthenogenetic eggs are produced meiotically or ameiotically, there is usually evidence that such production is a derivative of the usual gametogenetic processes, and few, if any, cytologists now deny that parthenogenesis is a derivative of normal sexual reproduction.

If these things are true, there is no such thing as an 'asexual egg'. An egg is always a gamete, usually formed in a definite ovary, and, whether this ovary belongs to a female or a hermaphroditic organism, it is associated with femaleness and, of course, sex. Commonly, also, it is stored temporarily and then conducted from the body in accessory female reproductive organs. So far, certainly, there is nothing in common with asexual methods of reproduction other than the fact that a step which may lead to the production of a new individual has been taken.

Let us consider an informative example such as the occurrence of haploid parthenogenesis in the honey bee. All eggs are reduced and haploid, having undergone typical gametogenesis. Such eggs are produced normally only in the ovaries of the queen. Assuming the marriage flight has occurred, most of these eggs will be fertilized and produce females, mostly workers. But some of these eggs may remain unfertilized and develop into drones or males. Whether any particular egg shall be fertilized or not depends upon the physiological operation of the female machinery which allows sperm access to the eggs or denies it. Thus the sex of the offspring is determined. To recapitulate: *female* gametes, produced in *female* gonads, and stored in *female* accessory organs are either fertilized or not, depending upon the operation of the *female* reproductive machinery, which has been supplied previously with *male* gametes. If the eggs are fertilized they become *females*, if they remain unfertilized they become *males*. There is not an asexual atom in this whole procedure!

If this may be considered an extreme case, it nevertheless differs from other parthenogenetic cycles only in degree. As Wilson[1] quotes Brachet with approval, there is "a veritable bridge set up by Nature between fertilization and natural parthenogenesis". There may be transition also between normal sexual reproduction and asexual reproduction, but such transitions do not follow the route of parthenogenesis. Sexual reproduction is better characterized as reproduction which involves gamete formation, and thus is distinguished from asexual reproduction which does not involve gamete formation. To continue to describe parthenogenesis as asexual can only lead to confusion as we attempt to understand the evolution of specialized sexual reproductive processes from the more primitive asexual mechanisms which involve mainly budding and fission. Proper usage of the terms already available should make it possible for us to express ourselves clearly and effectively in discussing this general topic along the lines indicated. However, if there are good and sufficient reasons for continuing to refer to parthenogenesis as an asexual process in spite of the foregoing statements, then we should all benefit by having them clearly set forth.

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United States. Oct. 10.

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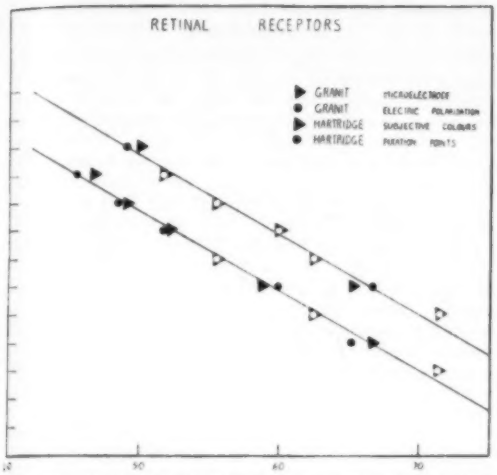
The Retinal Receptors

DARTNALL'S discovery, reported in *Nature* of August 5, p. 207, of two new retinal pigments, visual yellow 2 and visual red, together with the fundamental observation that the crests of the known pigments are separated by equal frequency intervals, leads to the expectation of the discovery of further pigments. Since those already known are iodopsin (visual blue) (0·57 μ), visual violet (0·533 μ), visual purple (0·502 μ), visual red (0·475 μ) and visual yellow 2 (0·407 μ), the additional ones in the visible spectrum should be visual green (0·655 μ), visual blue-green (0·609 μ), visual orange (0·450 μ) and visual yellow 1 (0·427 μ). Dartnall's discovery also raises an important issue, namely, are the results of these physico-chemical investigations in agreement with the physiological ones which have been performed by other workers, both on man and on certain animals? If agreement is found, the reliability of both types of investigation is greatly increased. In the accompanying table are shown: (*a*) the wavelengths of the crests which would be expected on a quantum theory basis; (*b*) those found by Granit in animals' eyes by means of the micro-electrode method; (*c*) those found by Granit in animals' eyes using the electric polarization method; (*d*) those



Upper graph, Granit's animal receptors; lower graph, writer's human receptors; both drawn on Dartnall's equal frequency interval lines. Where triangles and dots coincide the latter are shown as white dots. Equal frequency steps, vertical. Frequencies, horizontal

found by me in the human eye by means of the fixation-point method; (*c*) those found by me in the human eye by means of the subjective colour method.

Quantum theory basis	Granit micro-electrode	Granit electric polarization	Hartridge fixation points	Hartridge subjective colours
655	—	—	660	640
609	600	610	620	610
570	580	—	580	575
533	540	520	540	540
502	500	—	500	510
475	480	—	—	480
450	460	450	460	450
427	420	—	420	420

These results are plotted in the chart. The two full lines correspond to Dartnall's equal frequency interval relationship. The plotted points in the upper graph show Granit's results, by circles with the micro-electrode method and by triangles with electric polarization method. The plotted points in the lower graph show my results, by circles with the fixation point method, and by triangles with the subjective colour method.

It will be observed that there is good agreement in both cases between the theoretical curve and the experimental points both for man and for animals. It will be remembered that Dartnall has also found good agreement between the theoretical curve and the pigments which have been so far found in the retina of the tench. Putting these facts together, it follows that men and certain animals have receptors in their retina, the response curves of which have crests very close in spectral position to those to be expected if the retinal pigments act as photocatalysts for those receptors. This conclusion is important, because until now it has been a matter for conjecture whether the photopic receptors, the cones, have a similar or a different mechanism from that of the scotopic receptors, the rods. It now appears certain that the mechanisms are closely similar, visual purple acting as a photocatalyst for the rods, and a number of different, but chemically related, pigments acting as photocatalyst for the cones.

But there is another point to be considered. In order that the photopic pigments may form a series, the members of which differ from one another by equal frequency intervals, it follows that they must be chemically related, differing from one another, however, by the substitution of one chemical group for another. To take a very simple example, one pigment might have one hydroxyl group somewhere in its molecule, the next pigment in the series might have two such hydroxyl groups, the third might have three, and so on. Such a scheme would provide a series of related pigments with an equal frequency interval between them.

Now if one of these pigments could be identified, it should not be difficult to ascertain the identity of one of the others, and thus to ascertain the chemical relationship between them. This should lead to the recognition of the chemical structure of them all.

Evidence is to be presented elsewhere for the hypothesis that the yellow pigment with a crest at 0·475 μ, that is, the photocatalyst for vision in the blue part of the spectrum, is a carotinoid, related to xanthophyll, $C_{40}H_{56}O_2$. If this be true, the relationship between this visual pigment and vitamin A is established. It will be recollected in this connexion that visual purple is itself a derivative of vitamin A.

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Genetical Reduction of a Reproductive Unit in Relation to the Male–Female Ratio

IN two previous papers[1,2], I have referred to artificial insemination from the genetical point of view and arrived at the conclusion that the genetical reduction it produces is its main disadvantage. Recently, Sir John Russell in a lecture on "World Population and World Food Supplies"[3] gave hopes of a better future. Referring to artificial insemination he said: "We may yet live to see bulls, other than a small select aristocracy, become unwanted anachronisms". My own opinion is that even in cattle democracy is a fundamental necessity, therefore I fully share Sir John's "lurking suspicion that Nature may resent being unceremoniously bundled out in this way", as he states a few lines after his rather sweeping statement. Nature would resent the genetical reduction produced by the increase of females in the ratio of 1 male to *n* females.

In species with diploid genetical composition, a complete haploid set of chromosomes is inherited from the father and another set from the mother. In a reproductive unit—1 male to *n* females—50 per cent of the total number of chromosomes of the offspring come from the father independently of the number *n* of females. Assuming that any animal has the capacity of carrying the same number of genes as any other of the same species, the total number of chromosomes inherited by the offspring of a reproductive unit decreases as *n* increases in the ratio of 1 male to *n* females.

For example, if a group of 100 females is divided into five reproductive units with one male each, the total amount of haploid sets inherited by the offspring is 210. If the group is provided with only one male, 202 sets are inherited. In a monogamous population 100 females form 100 reproductive units, and the

maximum number of haploid sets, that is, 400, is available. In the first case, the reduction is measured by the ratio 210/400 and in the second by 202/400. The reduction is 1·9 : 1 and 1·98 : 1 respectively. If this happens again for a second generation, the reduction is greater, since 100 females are not carriers of 200 different sets of chromosomes but only 105 and 101 respectively. If the former is divided again into five reproductive units with a male each, 115 sets of chromosomes will be available for the offspring; but the second unit with one male will be able to transmit only 103 sets of chromosomes. The measure of reduction is given by the ratio 115/400 in the first case and 103/400 in the second. The reduction in the third generation will be 67·5/400 and 53·5/400, and so on in further generations. The formula for the reduction is:

$$\frac{(2^x - 1 + n_1)n_2}{(2^x - 1 + n_2)n_1},$$

where x is the number of generations in which a given number of females has had only one sire and n_1 and n_2 the number of females of the units compared. This formula measures the genetical reduction produced by artificial insemination compared either with a monogamous population where one male corresponds to one female, or with a population with any number of females per reproductive unit.

If artificial insemination is used during ten generations in a group of 2,000 females the reduction, compared with a monogamous population, will be 3,023/2,048,000, which is equal to 0·00148. With the ratio 1 male/20 females, the reduction will be 1,043/20,480, which is equal to 0·051.

For example, from the genetical point of view, a population of 100,000 females inseminated with only fifty males each generation during ten generations is able to transmit the same number of genes as another made up of 148 females with a male each, provided there is no inbreeding in both cases. If the group was inseminated by 5,000 males each generation, also during ten generations, the number of genes would be that of a group of 5,100 females of a monogamous population without inbreeding. This means that as the number of generations increases the reproductive units tend to carry the same number of genes independently of the number of females. This point is almost reached after ten generations for groups of 1 male/20 females and after twenty generations for units of 1 male/2,000 females.

From a genetical point of view, by means of artificial insemination a numerous herd is converted into the equivalent of one of small number, and as the only source of variability is the existence of different individuals, it will be fixed in its present state of evolution. This is a serious handicap for the improvement of its qualities or adaptation to future needs. Artificial insemination should be used, therefore, only during a few generations, when a breed is in a stage of either quantitative or qualitative diffusion.

I wish to thank Prof. R. A. Fisher for reading this communication and Dr. J. T. Lewis for his interest and criticism.

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Sexual Season of the Ewe and Daylight Environment

AN exact knowledge of the duration of the breeding season of improved breeds of sheep in relation to daylight changes has an important bearing on the export of such breeds overseas, determining the areas in which different breeds can be used. Transferring sheep from one latitude to another even within the same hemisphere has been shown to have an effect on the ovarian rhythm through the change of light environment[1,2]. J. Hammond, jun.[3], states that the breeding season of Suffolks is evenly spaced around the shortest day over a period when the length of daylight is 11½ hours or less. J. Hammond, sen.[4], relates breed differences in the duration of the breeding season to the geographical origin of breed. Yeates[5] reports that the onset and end of the breeding season occurs 10–14 weeks after the seasonal daylight curve changes over to shorter or longer daylight hours, respectively.

A study of the natural breeding season of the non-pregnant ewe was started in October 1948, the materials being six British pure breeds, some of which had been maintained locally in Cambridge and some were purchased from flock breeders elsewhere. The breeds investigated can be classified into three groups:

(1) Breeds with a very restricted breeding season: Blackface Mountain, Border Leicester and Welsh Mountain, which had a breeding season of 19 weeks average duration, and an average number of 7 cycles per ewe. They bred when the length of daylight was 11½–12½ hr. or less. These breeds originated in the Scottish Highlands, Scotland and the Welsh mountains respectively, the first and last at high altitudes (about 2,000 ft. above sea-level).

(2) Breeds of medium-length breeding season: Romney Marsh and Suffolk, which had a breeding season of 26 weeks average duration and the ewes experienced on an average 10 cycles. They bred when the length of daylight was 12–13½ hr. or less. These breeds originated in the southern counties of England.

(3) Breed with a prolonged season: the Dorset Horn, which had a breeding season of 32 weeks average duration with 13 cycles. It bred when the hours of daylight were 12–17 or less. This breed probably originated partly from Merinos introduced from Spain.

Thus there is a relationship between the duration of the breeding season and the latitude and altitude of origin of the breed.

The differences in the extension of the breeding season were mostly due to different dates of onset. The centre date of the season coincided with the shortest day in most breeds, whereas in the Dorset Horn it occurred seven weeks before December 21. There was no correlation between the dates of onset or end of the breeding season, on one hand; and the dates of change-over of the daylight curve, on the other hand. In group (1) breeds, the ewes came on heat 17 weeks after the longest day and went off 9 weeks after the shortest day; whereas in the Dorset Horn they came on and off 4 and 10 weeks respectively from the change-over of the daylight curve.

The ovarian activity of ewe lambs lasted approximately only one-fourth to one-third of that of adults of the same breed, as judged by the duration of the breeding season and by the number of œstrous periods. The centre date for ewe lambs always occurred just after the shortest day, and they experienced their first heat just prior to the shortest day.

Silent heat occurred with different frequencies in the breed groups, with a range of 0·25–1·40 silent heats per adult ewe per breeding season. The average of silent heats expressed as a percentage of total cycles detected was 7 (62 per cent of those occurring after the shortest day).

Post-partum heat was experienced in 56 per cent of lactating Suffolk ewes, when the length of daylight (January–March) was 10–12 hr., and the length of the lactation anœstrus ranged from 1 to 9 weeks. The post-partum conception-rate was 50 per cent, and it depended on suckling conditions.

This work is being carried out in the Animal Research Station, Cambridge, while on study leave from the Fouad I University of Egypt. It is still in progress, and detailed results will be published elsewhere. I am indebted to Dr. John Hammond for his continuous advice and encouragement.

E. S. E. Hafez

School of Agriculture,
Cambridge. July 10.

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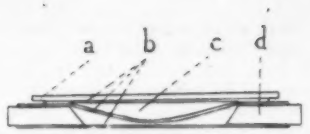
Experimental Rearing of the British Harvest Mite to the Adult Stage

The periodical revivals of attempts at rearing harvest mites during the past half-century have led to few successes, and *Trombicula autumnalis*, the British harvest mite, has evaded the efforts of Hirst[1], André[2], Keay[3], and others to rear it further than the nymphal stage. In view of the permanent hypogean existence of the nymphs and adults at some considerable depth below the surface of the soil (Cockings)[4], it is not surprising that difficulties have been encountered in trying to discover the food and environmental requirements of the post-larval stages.

Miyajima and Okumura[5] first gained success in rearing *T. akamushi* from the larva to the adult, but their account omitted much needful detail. The American workers Melvin[6], Michener[7] and Jenkins[8] successfully maintained colonies of *Eutrombicula batatas* in 1946, mainly for the purpose of testing acaricides on the mites. The rearing methods adopted, whether successful or otherwise, depended primarily on culturing the mites either in a layer of some suitable medium, like moist sterile soil, or in moist cotton wool, and mosquito eggs were recommended as the best food for rearing the nymphs and adults. The methods employed by previous workers were unsuitable for following closely the progressive change of form of individual mites through the phases of their peculiar and complex post-embryonic growth-cycle. Since my aim in rearing this mite was primarily to include its peculiar type of development in a study on growth in the Acarina, a convenient method had to be devised. In 1949, after many attempts during previous years, the following method turned out to be successful.

The larvæ, collected from the field, were nourished on young mice. These were kept individually inside inverted glass funnels resting upon a wire gauze over Petri dishes, so that the engorged larvæ were trapped as they fell off the host. The engorged larvæ



The filter-paper cell: *a*, glass cover; *b*, filter papers; *c*, rearing chamber; *d*, 'Perspex' frame

were transferred to special filter-paper cells: each cell consisted of a 'Perspex' framework (with 4-cm. sides, 0·3 cm. thick, and with a central aperture) which supported two squares of filter paper of appropriate size, one of which was depressed into the aperture so that the space between the two filter papers formed the chamber for housing the engorged larvæ and later stages (see diagram). The nymphs fed best on a mixture of moist chicken fæces, agar, yeast and molasses, the three last being constituents of a food used for culturing *Drosophila*. The nymphs showed no desire to feed on the eggs of *Aedes ægypti*, and both young and old nymphs seemed incapable of piercing the outer membranes even after the eggs were moistened. The fully engorged nymphs imbibe water and increase in bulk considerably before elongating and exhibiting the pupa-like features of the pre-adult transition stage, which closely resembles that preceding the emergence of the active nymph. The mortality-rate of fed nymphs was very high, but six adults of various sizes were obtained; the pre-adult developmental phase lasted about thirty-six days at room temperature, 100 per cent relative humidity and about twenty-eight days at 25° C., 100 per cent relative humidity. Attempts to force egg-laying at high temperatures failed.

So far as I am aware, this is the first time that *T. autumnalis* has been reared experimentally from the larva to the adult stage. Details of the method are included in a completed paper on the growth and development of this mite, which I hope to publish elsewhere.

B. M. Jones

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July 4.

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An Inhibitor of Salt Absorption in Root Tissue of Red Beet

De Kock and Hunter reported in *Nature* of September 9, p. 440, the extraction from the seeds of sugar beet of a water-soluble oil which inhibited the respiration of root tissues and the germination of seeds.

Recent experiments in this Department have indicated the presence in red beetroot during winter storage of a water-soluble substance which inhibits the ability of beetroot cells to absorb inorganic salts from solutions. This was shown by the temporary cessation of salt absorption when a concentrated water-extract of beetroot was added to a solution from which disks of tissue were absorbing manganese chloride. The addition to such solutions of the residues from chloroform extractions of ground-up

beet tissue had no effect, however. The active substance has not yet been separated from the water-extract.

The presence of an inhibiting substance in beetroot during storage accounts for the delay in the commencement of both cation and anion absorption from solutions for about fifty hours after cutting the intact roots. The delay can be shortened by washing the cut tissue and so removing the inhibitor. It must be assumed that the substance will also disappear from tissue by a natural process, probably of a respiratory nature, since when disks are kept in a limited volume of solution they eventually begin to absorb salts. The inhibiting substance is thought to be concerned with the natural dormancy of beetroot during the winter, because extracts of young freshly pulled roots and old stored roots in the early summer do not inhibit salt absorption.

The results will be reported fully elsewhere.

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Incidence of Salmonellæ in Fæces of Dogs suffering from Distemper

Cruickshank and Williams Smith[1] found five of five hundred healthy dogs (1 per cent) in London to be excreting salmonellæ in their fæces. The technical methods used in this investigation consisted, briefly, in plating the samples directly on to Leifson's agar, and also after preliminary enrichment in selenite *F* medium and in tetrathionate broth. Wolff, Henderson and McCallum[2] examined fæcal specimens from a hundred city dogs in Michigan by preliminary incubation in tetrathionate broth followed by plating on *S.S.* agar. They found 18 (18 per cent) to be positive for salmonellæ. Most of the positive samples were obtained from dogs suffering from distemper or from dogs maintained in a kennel where outbreaks of distemper and enteritis had occurred in the six months previous to sampling. Kintner[3], simply by direct plating on *S.S.* agar, found 13 of 71 dogs (18 per cent) brought to the Ohio State Veterinary Clinic for treatment to be excreting salmonellæ in their fæces. Of the dogs in this investigation, 50 per cent of those suffering from distemper were positive for salmonellæ, as were 10 per cent of the non-distemper cases.

In view of the marked difference between the American and British figures, it was decided to investigate the problem further. With the help of a number of veterinary surgeons practising in the London area, rectal swabs were examined from a hundred dogs suffering from distemper or para-distemper (hard pad disease). The methods employed were those used by Cruickshank and Williams Smith[1]. Only one of the samples (1 per cent) was found to contain salmonellæ. This organism, *Salm. typhimurium*, was isolated after preliminary enrichment in selenite *F* medium.

These results suggest that there is little or no difference between the incidence of salmonellæ in the fæces of normal and distemper-infected dogs in London, and that distemper alone does not account for the incidence of salmonellæ in the fæces of dogs in American cities being so much higher than those in London. Kintner[3] considers that the high incidence in American dogs may be related to the diet, and quotes references to show the very high percentage of dog foods which may contain salmonellæ. Wolff *et al.*[2] also noted that some of the dogs examined by them were fed on reject eggs, and that the salmonellæ isolated from many of those dogs were of the 'dried-egg' variety. It is possible, therefore, that the difference between the American and British figures may be accounted for by a difference in diet.

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July 7.

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Planck's Constant and the Fine-Structure Constant

Advances in fundamental theory have often been guided by the principle that reliance is to be placed on the most directly observed quantities, that is, those involving least theoretical assumptions. This letter indicates the interpretations of Planck's constant (h) and of the fine-structure constant (α) which follow from this principle[1].

Of the measurements on which quantum theory is based, the most direct are lengths (wave-lengths, path curvatures). As is well known, the three classical theories of gravitation, electron dynamics, and the electromagnetic field are each scale-free, there being no constant of the dimensions of a length in their laws, taken separately. But the quantum theory of discrete eigenstates is scale-fixed, h providing in combination with other constants (for example, in the combinations h/mc, $h^2/4\pi^2me^2$, and $h^2c/2\pi me^4$, where m equals electron mass) the basic standards of linear scale required to represent these states. Apart from heat effects, which involve less direct measurements and more assumptions, h is always calculated from characteristic lengths or from ratios of lengths. Thus the above principle suggests that from the point of view of a future theory the characteristic feature of the phenomena involving h is their definiteness of scale, rather than the 'quantization' of action or energy. (Lengths of the order e^2/mc^2 are less reliable than the above lengths involving h, for they are less directly measured and rest on a high extrapolation of the inverse square law from larger-scale observations.)

The most direct measurements yielding α involve ratios of the above three lengths (ratios of characteristic wave-lengths, and of these to atomic radii) or of wave-lengths to path curvatures (for example, in the photo-electric effect). Our principle therefore requires α to be interpreted as the ratio of fundamental lengths, as has already been proposed[2] on less general grounds. It follows that a derivation of α must show how assumptions containing explicitly or implicitly one fundamental length, and no arbitrary pure numbers determinable only by experiment, can account for the presence in current theory of several fundamental lengths; compare Heisenberg's idea[3] that "the introduction of a fundamental length may be bound up with a new fundamental modification of the formalism".

This suggests that in a future theory lengths may enjoy a more fundamental status than times. This need not conflict with relativistic invariance within its valid field, that is, where four co-ordinates are used, for the new theory may take advantage of the fact that in quantum-mechanical stationary states there is no observable time co-ordinate.

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Decay Energy of Beryllium-8 Nuclei observed in Cosmic Ray Stars

DURING the examination of about three thousand cosmic stars in Ilford *G5* plates 200 μ thick, exposed at balloon altitude, we observed in several cases two prongs of comparable length, making a small angle with each other, ending in the emulsion and looking like α-particles of about 10–20 MeV.

One may suppose that such pairs are the decay products of beryllium-8 nuclei, ejected from the nucleus and disintegrating before travelling an observable distance, according to the known reaction $Be^8 \rightarrow 2He^4 + Q$.

On this assumption, the kinetic energy Q of the two α-particles in the centre-of-mass system can be easily computed from the range of the α-particles and the initial angle of their tracks[1].

A rather narrow band of energy for the value of Q was found about 100 keV. (16 pairs between 63 and 100 keV.). A broader and lower peak was also observed around 600 keV. (12 pairs between 500 and 750 keV.). Only four cases were found outside these two peaks.

In the 100-keV. band we have six events which are readily analysed, corresponding to $Q = 76$, 94, 89, 91, 77 and 92 keV. The main cause of error is, in most cases, the difficulty in measuring the angle; this is principally due to the scattering of the tracks. The estimated error ranges from $\pm$ 9 keV. to $\pm$ 19 keV.

In ten other events, for which the length of the tracks did not allow a definite identification of the particles, the measured values of Q vary from 63 to 100 keV., with possible errors ranging from $\pm$ 25 to $\pm$ 50 keV.

The decay energy of beryllium-8 in the ground-state has already been measured by various authors, using other methods. Recent results are those of Hemmendinger[2] (103 $\pm$ 10 keV.), and Tollestrup, Fowler and Lauritsen[3] (89 $\pm$ 5 keV.). Therefore, the 100-keV. peak we have observed can be attributed to beryllium-8 nuclei, emitted in the ground-state. Our measurements give a value $Q = 85 \pm 10$ keV., which is in good agreement with the previous results.

The broader band around 600 keV. may indicate the existence of some other nuclear process.

Sincere thanks are due to Prof. Leprince-Ringuet for his advice and direction, to the balloon staff of the laboratory of the École Polytechnique, and to Françoise Bousser and Mady Rougeul for the preliminary examination of the plates.

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Paris. July 9.

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Slow Neutron Cross-Sections of Molybdenum and Bromine

THE total neutron cross-sections of molybdenum and bromine have been measured between 0·05 and 10 eV. using a crystal spectrometer, and between 0·0025 and 0·1 eV. using a mechanical time-of-flight spectrometer. The crystal spectrometer is of the type described by Sturm[1] using the (110) planes of a calcium fluoride crystal in transmission. The mechanical spectrometer is similar to the one described by Brill and Lichtenberger[2]. Both instruments use the Harwell pile as a source of neutrons.

The molybdenum cross-section was measured using a 2½-in. square piece of molybdenum sheet (15·7 gm. per cm.[2]) which had been produced by rolling bars prepared by powder-metallurgy technique. (The sheet consisted of several thicknesses of 99·97 per cent pure molybdenum foil supplied by Johnson, Matthey and Co., Ltd.). The total cross-section as a function of energy is shown in Fig. 1. In the region from 0·0025 to 0·03 eV. the elastic scattering cross-section has been calculated from the theory of the transmission of slow neutrons through micro-crystalline materials[3], and the theoretical curve shown has been obtained by adding to these values the absorption cross-section

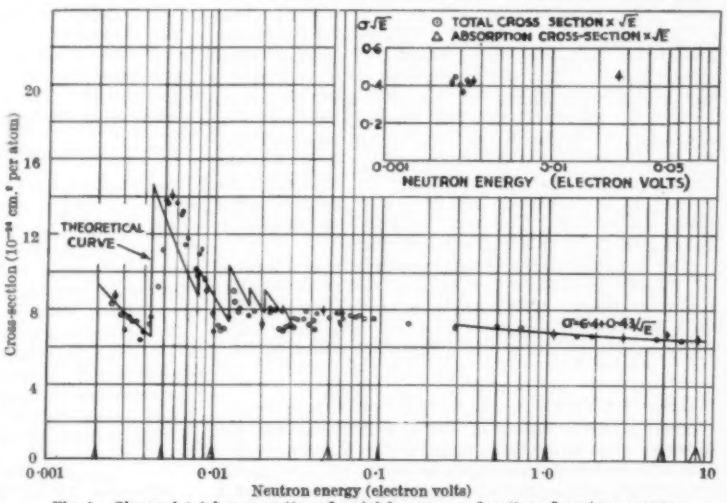

Fig. 1. Observed total cross-section of molybdenum as a function of neutron energy

Fig. 2. Observed total cross-section of bromine as a function of neutron energy. The best $1/v$ line is $\sigma = 6{\cdot}2 + 1{\cdot}1/\sqrt{E}$ barns

deduced from the experimental results. It can be seen that the experimental points are in fair agreement with the theoretical curve, but that in the region of 0·005 eV. there is a difference of 10–15 per cent. This is probably due to a preferred orientation of the crystals in the direction of rolling, which has been observed by X-ray analysis.

The absorption cross-section of our sample at 0·025 eV. has been measured by E. Lockett[4] using the pile oscillator method, and a value of $2{\cdot}95 \pm 0{\cdot}15$ barns obtained. Assuming the absorption cross-section follows a $1/v$ law, its value below 0·004 eV. obtained from this result is approximately equal to the measured total cross-section (see inset to Fig. 1). Hence the incoherent scattering (due to spin and isotope effects) and the inelastic scattering cross-sections must be less than 0·3 barn. The theoretical value for the inelastic scattering cross-section at this point is 0·15 barn.

It can be assumed that above 0·25 eV. the total scattering cross-section becomes constant, and from 0·25 to 10 eV. the experimental points are best fitted by the equation:

$$\sigma_t = 6{\cdot}4 + \frac{0{\cdot}43}{\sqrt{E}} \text{ barns.} \qquad (1)$$

The second term in this equation represents the absorption cross-section and is equal to the total cross-section below 0·004 eV. The best value of the absorption cross-section at 0·025 eV. deduced from all our data is $2{\cdot}7 \pm 0{\cdot}1$ barns, which is in reasonable agreement with values of 2·4, 2·9 and 2·7 barns quoted by Ross and Story[6]. The constant term in equation (1) is the bound scattering cross-section, because neutrons in the energy-range in which the measurements were made cannot impart sufficient energy to the molybdenum nuclei to displace them from the lattice. The free scattering cross-section calculated from this value is 6·3 barns.

The bromine measurements were made on a sample of 'Analar' bromine (17·8 gm./cm.^{2}) of 99·9 per cent nominal purity. The total cross-section of bromine as a function of energy is shown in Fig. 2, and the experimental points are best fitted by the equation:

$$\sigma_t = 6{\cdot}2 + \frac{1{\cdot}1}{\sqrt{E}} \text{ barns.}$$

This gives a value of $6{\cdot}2 \pm 0{\cdot}2$ barns for the scattering cross-section, and $6{\cdot}9 \pm 0{\cdot}3$ barns for the absorption cross-section at 0·025 eV., in agreement with an activation measurement of $6{\cdot}6 \pm 1{\cdot}3$ barns reported by Seren, Friedlander and Turkel[8].

We would like to thank Mr. E. Lockett for his measurement of the thermal absorption cross-section of molybdenum.

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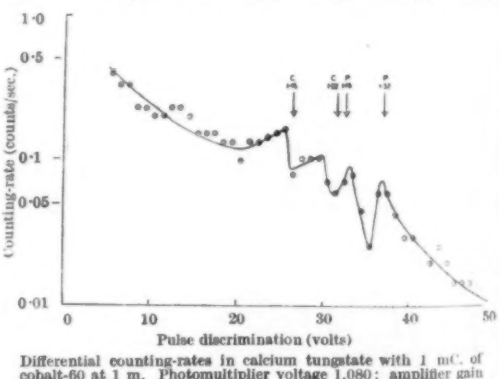
Measurement of Gamma-Ray Energies with the Scintillation Counter

The use of the scintillation counter as a gamma-ray spectrometer has been described by Pringle, Roulston and Taylor[1], Johannson[2], MacIntyre and Hofstadter[3], Cavanagh[4] and other workers. However, the resolutions obtained have in general been poor, and quantitative measurements of gamma-ray energies and relative intensities difficult to make.

Lack of resolution may be attributed to three main effects. First, the optical efficiency of the system will vary through the volume of the crystal, and the number of photons incident upon the photomultiplier cathode will not be constant for scintillations of equal size produced at different positions in the crystal. Secondly, some secondary electrons may escape from the crystal before expending all their energy; mono-energetic secondary electrons thus may not produce scintillations of uniform size. Finally, the size of pulse at the photomultiplier output will be subject to large statistical variations where only a few photons are incident upon the photocathode per scintillation.

These effects may be reduced by the use of small crystals of high density in a system the optical efficiency of which is as high as possible. Calcium tungstate is particularly suitable having a density of 6·06 gm./c.c., and the accompanying graph shows the differential curve of counting-rate against pulse-discriminator setting obtained when a small (0·124 gm.) crystal of this material placed in direct contact with the envelope of an uncooled 1*P*21 photomultiplier was irradiated with the gamma-radiation of cobalt-60. The pulses at the photomultiplier output were amplified in a linear amplifier (type 1008)



Differential counting-rates in calcium tungstate with 1 mC. of cobalt-60 at 1 m. Photomultiplier voltage 1,080; amplifier gain 1,600; mass of crystal 0·1244 gm.; resolving time 200 μsec.

operating at a gain of 1,600, and recorded in a counting-rate meter (type 1037*A*) incorporating a pulse discriminator circuit calibrated directly in volts. The integral curve of counting-rate against pulse-discriminator setting was differentiated by taking the increment in counting-rate over each one-volt step in pulse discrimination. All counting-rates are corrected for background effects.

The twin peaks and edges due to the photo-electric absorption and Compton scattering of the two gamma-rays of energy 1·16 and 1·32 MeV. are clearly resolved. The arrows give the theoretical position of these peaks and edges calculated from the observed position of the 1·32-MeV. photo-electron peak, assuming a linear relationship between secondary electron energy and pulse size. The rise in the curve at low pulse discrimination may be attributed to degenerate radiation scattered from the photomultiplier housing and crystal mounting.

Similar measurements have been made using a small crystal of thallium-activated potassium iodide. Owing to the lower density (3·13), resolution is reduced, and a large increase in counting-rate appears below 20 volts discrimination owing to the single-photon phosphorescent emission of this material; it is of interest that the gradient of this portion of the curve is similar to that of the noise background of the photomultiplier, showing that it represents the emission of single electrons at the photocathode. This confirms the single-photon character of the phosphorescent emission of the luminophor[5].

Some interesting results have been obtained with radioisotopes other than cobalt-60. For example, in the case of gold-198 the presence of a low-intensity gamma-ray of energy 1·1 MeV., also reported by Pringle[6], is verified. It is estimated, by comparison with the curve for cobalt-60, that the probability of occurrence of this gamma-ray is of the order of 1 per cent.

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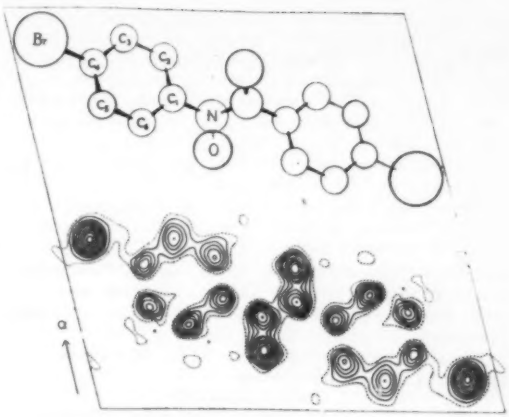
Crystal Structure of the Dimer of *para*-Bromonitrosobenzene

Aromatic nitrosobenzenes are dimeric in the solid state, but the nature of the link between the two halves of the molecule is not known[1]. An attempt to solve the problem has been made using the methods of X-ray analysis on crystals of *para*-chloro- and *para*-bromo-nitrosobenzene. The chlorine or bromine atom was introduced to make possible the solution of the structure by the heavy-atom method.

These two derivatives show many similarities in crystal morphology, but the crystals of the chloro-compound were triclinic and twinned; the structure determination was therefore carried out on *p*-bromo-nitrosobenzene. The crystals of this substance are lath-shaped, elongated along *b*; they are monoclinic, with space group $P2_1/a$, and cell dimensions

$a = 12{\cdot}98$ A., $b = 3{\cdot}90$ A., $c = 12{\cdot}73$ A. and $\beta = 104°$.

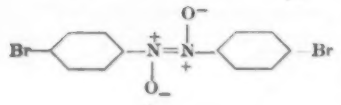


In the lower half of the cell is drawn the projection of the electron density on to the plane (010). Contours are drawn at intervals of 1 electron per A.^{2}, starting with the dotted contour at 2 electrons per A.^{2}. On the bromine atom the interval is 5 electrons per A.^{2}. The upper half of the cell shows the arrangement of one molecule in this projection. Of the two molecules in the cell, one is tilted upwards to the left as shown, and the other is tilted downwards to the right

The unit cell contains two molecules of the dimer (molec. wt. 372·0). It also contains the asymmetric unit repeated four times, which shows that the two halves of the molecule are identical, and are related by a centre of symmetry.

Patterson and electron-density maps were calculated for projections on to the (010) and (100) planes. From these the general structure of the dimer is clearly seen. The accompanying diagram shows the projection of the electron density on to (010). So far as has been ascertained at present, the bromine atom, the benzene ring and the nitrogen atom are in the same plane, tilted at a slight angle from the plane (010), and the bonds from the nitrogen atom to the carbon atom, the oxygen atom, and the other nitrogen atom seem also to be planar but tilted at an angle to the benzene ring.

The second projection calculated (not shown here) is poorly resolved, and from this it is difficult to assign accurate *y*-co-ordinates to the atoms. Hence, there is a considerable degree of uncertainty in the positions of some atoms, notably oxygen and nitrogen, the two that are most interesting. By making use of the (010) projection and of the geometry of the benzene ring, the distance C_4—Br may be given as 1·88 ± 0·04 A., which agrees excellently with the value 1·89 ± 0·03 A. obtained by Clews and Cochran in a bromopyrimidine; similarly, C_1—N is calculated as 1·40 A., in agreement with the value 1·41 A. in *trans*-azobenzene[2]. If the bonds from the nitrogen atom are assumed planar, with an angle of 120° between them, the calculated bond-length for N—N is 1·36 A. and for N—O is 1·43 A. Comparison with the second projection suggests, however, that the bond angles are not quite identical and that the bond-lengths are rather shorter—probably N—N about 1·31 A. and N—O about 1·35 A., very similar to those in the dinitrososulphite ion[4]. In any event, the N—N bond-length lies between the values for a single bond, 1·47 A.[5], and a double bond, 1·23 A.[3], while the N—O link is more nearly single bond in character; compare N—O in hydroxylamine, 1·45 A.[6], and in trimethylamine oxide, 1·36 A.[7]. In terms of bond diagrams,



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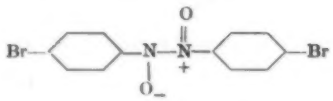

II

structure I would appear most nearly to represent the bond distribution, probably with some contribution from structures of the type of II (compare Hammick, Plant and others[1]).

We are very grateful to Mr. D. Ll. Hammick, who suggested this problem to us.

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Lattice Parameters of Martensite and of Austenite

THE lattice parameters of martensite and austenite in steels (carbon content varying from 0·57 to 1·74 per cent) have been extensively studied; but considerable discrepancies exist in the values obtained by different investigators. The quenching temperatures used, however, differed, and quite often are not quoted. Some authors attribute the discrepancies in the lattice constants to the surface decarburization of the specimen[1]. It is significant that the diameters of the X-ray cameras used by the majority of previous experimenters were less than 9 cm.

In the present investigations, the lattice parameters were established for steels containing 1·25, 1·20, 0·90, 0·89, 0·75 and 0·45 per cent of carbon. A detailed account concerning the chemical analysis, the heat treatment, preparation of the specimens and the X-ray technique has been given in previous communications[2]. X-ray diffraction photographs were taken both with 9-cm. and 19-cm. Debye–Scherrer cameras, using cobalt radiation and an iron filter. The homogeneity of the specimens was examined in some cases by using different radiation. The results of the measurements of the lattice parameters are summarized in the accompanying table.

The figures obtained for the lattice spacing of austenite satisfy the Dannatt–Wratej's straight-line equation[3], and the existence of retained austenite in quenched steel with 0·45 per cent carbon entirely confirms the recent findings of other investigators[4]. Further work concerning the influence of very low temperatures on the physical properties of the specimens is in progress.

Carbon (per cent)	Martensite			Austenite
	c Parameter (A.)	*a* Parameter (A.)	*c*/*a*	*a* parameter (A.)
1·25	3·008	2·842	1·058	3·6043
1·20	3·005	2·843	1·057	3·6020
0·90	2·963	2·847	1·041	3·5881
0·89	2·962	2·849	1·040	3·5879
0·75	2·939	2·850	1·031	3·5816
0·45	—	—	—	3·5680

I wish to thank Prof. C. W. Dannatt, head of the Department, for providing the laboratory facilities, Dr. A. J. E. Welch, of the Chemistry Department of this College, for the use of X-ray apparatus, and my assistant, Mr. R. Sidorowicz, for help during the work.

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Absorption of Ultrasonics in Liquids from Thermal Considerations

THE thermal effect of high-frequency sound waves passing through a liquid has been studied by a number of authors, particularly by Richards[1] and Mastagli[2]. Their interest was, however, limited to the determination of rise of temperature in the liquid, and to relating that rise with chemical constitution. Further, their investigations were conducted only at the exact resonant frequency of the crystal. In our experiments, we have studied the heating effect produced in the liquid as the frequency of the driving voltage is continuously varied around the fundamental. We have thus another method of studying the resonance condition of the vibrating crystal through the production of heat.

The experiments were conducted with a quartz plate having the fundamental at 420 kc./sec. placed in the liquid contained in a double-walled calorimeter. The usual corrections for the pronounced dielectric heating of the liquid and for radiation loss were made. Seven organic liquids were studied and graphs were drawn for each liquid relating the thermal output with frequency around resonance. The results of our investigations at the fundamental frequency are given in the accompanying table, the heat output shown being that at peak resonance.

Liquid	Heat output in calories	$\alpha/f^2 \times 10^{17}$ (calc.)*	Heat output taking that in carbon tetrachloride as unity	α/f^2 taking that of carbon tetrachloride as unity
Carbon tetrachloride	148·4	20·4	1·00	1·00
Nitrobenzene	109·2	13·4	0·80	0·74
Ethyl acetate	73·6	8·3	0·49	0·41
Toluene	68·0	8·0	0·46	0·39
Benzene	63·0	8·0	0·42	0·39
Xylene	46·0	7·1	0·31	0·34
Carbon disulphide	38·7	5·0	0·27	0·26

* By the Stokes–Kirchhoff formula.

These results show that the quantity of heat produced in the liquids follows the order of their sound absorption. Further, the very close parallelism between the last two columns is noteworthy. It is obvious, therefore, that at least at the frequency under investigation, sound absorption, as interpreted by production of heat, follows the classical absorption formula.

Our results show that a larger amount of heat is produced in carbon tetrachloride than in benzene or carbon disulphide, and their ratios are in strict proportion to their coefficients of absorption, as they should from theoretical considerations. But it has been shown by other investigators[3], using different methods, that benzene and carbon disulphide exhibit anomalous absorption at higher frequencies of the order of 5 Mc./sec. and above. This would indicate departures from their proportionality, which is not the case here. It appears, therefore, that this anomalous absorption observed at these frequencies for the two liquids does not exist, at any rate at 420 kc./sec. and perhaps thereabout.

Details of this work will be published elsewhere; further work on similar lines using higher frequencies is in progress.

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A Venn Diagram Analogue Computer

Prompted by the thought that a computer for the Boolean algebra should be of value, an electronic Venn diagram analogue computer (abbreviated to 'VENDAC' locally) has been devised. The computer translates the symbolism of the algebra of classes into coded pulses rather than relay contact positions.

The classes *a*, *b*, *c*, etc., of the Venn diagram are represented by square wave-trains of periods T, $2T$, $4T$, etc., respectively, which are of equal amplitude, and are synchronized. In practice, the square waves operate 'gates' which pass or stop a rectangular wave train of period $T/2$. The sub-class *abc*, for example, is then represented by coincidence of pulses from the *a*, *b* and *c* square waves. By choosing the periods of the square waves as indicated, all possible sub-classes are included. The universal bounds 1 and 0 are represented by a rectangular wave of period $T/2$ and zero signal respectively.

Units performing operations analogous to the operations of the algebra are interconnected to establish polynomials, equations, and inequations, and the 'solution' can be made to appear on an oscilloscope screen.

The equivalents of the operations 'union' and 'intersection' are performed by non-additive mixers and coincidence circuits respectively. Circuits are provided to give an output signal which is the 'negative' of the input, that is, which yield the output 'not-*a*' for an input '*a*'. VENDAC contains units each of which may, by operating a switch, be made to perform any of these operations. Anti-coincidence circuits, each having a pair of input terminals, but with a common output terminal, allow equations and inequations to be set up. Anti-coincidence pulses at a pair of terminals establishing inequality yield a positive pulse of amplitude A at the output terminal, while anti-coincident pulses at a terminal pair establishing an equality give a negative pulse of amplitude $A/2$. The common output is led to the vertical-deflexion plates of an oscilloscope. A horizontal, linear time-base is synchronized with the period of the square wave of longest duration; for example, if only three classes, represented by waves of periods T, $2T$ and $4T$, are considered, the period of the horizontal sweep is $4T$. Each segment of the time-base of duration $T/2$ is identified with a sub-class by markers fixed to the oscilloscope screen. The existence or non-existence of a sub-class is then indicated by the presence of a positive pulse of amplitude A or a negative pulse of amplitude $A/2$ in the appropriate position. The occurrence of a positive pulse of amplitude $A/2$ indicates a 'contradiction' in the equations, while the absence of a deflexion at a given position means that nothing is known about the corresponding sub-class. The pattern on the oscilloscope screen is readily translated into a literal solution.

The manner in which the solution may be 'read' electronically, rather than visually, and the manner in which the multi-purpose technique may be introduced when the number of classes is large, are easily seen. Numerical problems and problems involving probability will be solved by adding circuits for integration and arithmetic operations, and automatic gain-controlled amplifiers to 'amplitude-modulate' the pulse trains.

Work on an experimental computer for a maximum of four classes is in progress, and the possibility of extending the technique to the algebra of a many-valued logic is being investigated.

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July 6.

Solubilities of the α_{II}- and β-Forms of Synthetic Polypeptides: Evidence for an α_{II}–β Transformation in the Amorphous Phase

In previous communications[1,2] from these Laboratories, it has been shown that the molecular chains of a number of synthetic polypeptides can exist in folded and extended configurations, and the X-ray and infra-red evidence which has accumulated so far is entirely consistent with the view that the folded form has the α_{II}-structure proposed by Ambrose and Hanby[3]. One purpose of this note is to bring forward evidence of a different kind which has a bearing on the structure of the molecular fold.

We have shown that in many cases the two forms are readily interconvertible; in particular, a complete transformation to the extended β-modification can be effected by treating the folded polymer (which we shall call the α_{II}-polypeptide) with formic acid. Some α_{II}-polypeptides with hydrocarbon side-chains are soluble in non-polar liquids, for example, benzene or carbon tetrachloride; the copolymer (degree of

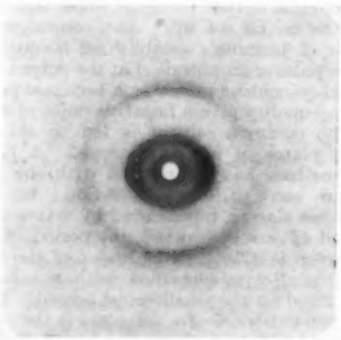

Fig. 1. X-Ray photograph of oriented fibres of the copolymer of DL-β-phenylalanine and DL-leucine, after treatment with acetic acid. $D = 4$ cm. Copper K_α radiation.

polymerization approximately 500) of DL-β-phenylalanine and DL-leucine (*A*) is an example of this. After conversion to the β-form by formic acid, the polymer was found to be completely insoluble in benzene or carbon tetrachloride at room temperatures. Experiments, which will be fully described elsewhere, have shown that this change in solubility cannot be the result of salt formation between the acid and the end amino-groups of the polymer.

The differential solubility probably results from the different disposition of the hydrogen bonds in the two forms. In the α_{II} fold, the hydrogen bonds are all intra-chain, and it is therefore not surprising that the α_{II}-form of a polypeptide such as copolymer *A* is soluble in non-polar liquids. On the other hand, the hydrogen bonds of the idealized β-form, being exclusively inter-chain, can act as cross-links, and might be expected to make this form insoluble in non-hydrogen bonding liquids. The β-polymer is, however, soluble in some liquids which can break hydrogen bonds, for example, chloroform and *m*-cresol. We feel that these results show that the configuration of the folded polypeptide is not the same as that proposed by Astbury and Bell[4] for α-keratin, in which at least two-thirds of the hydrogen bonds are not internally satisfied. This view is further strengthened by the results described later, which show that a partial transformation to the β-form is sufficient to produce insolubility in non-polar liquids.

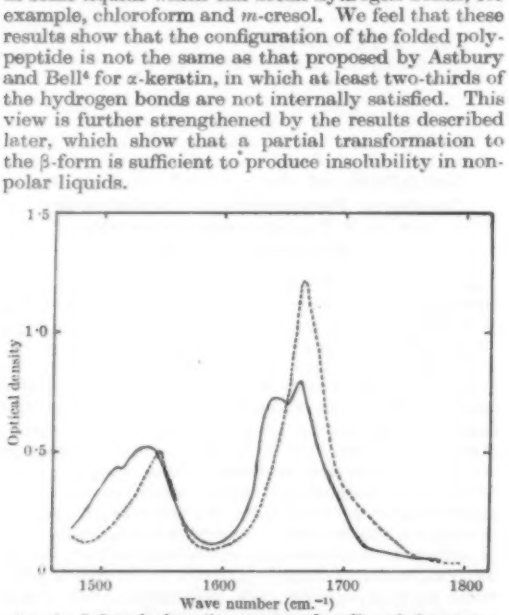

Fig. 2. Infra-red absorption spectra of a film of the same polypeptide before and after treatment with acetic acid (broken and full curves respectively)

We have previously reported[1] that carboxylic acids, other than formic, have little or no effect on the X-ray diagrams of polypeptide fibres. Fig. 1 is an X-ray photograph of oriented fibres of copolymer *A* which had been treated with glacial acetic acid for three minutes. So far as can be seen, it is a pure α_{II}-diagram with polar and equatorial spacings identical with those given by the original material. We now find, however, that a number of carboxylic acids, for example, acetic, propionic, *n*- and *iso*-butyric and *n*- and *iso*-caproic, can render fibres of copolymer *A* completely insoluble in benzene at room temperatures. The insolubility was again not connected with salt formation, and suggested that some transformation to the β-form had taken place.

This was confirmed by infra-red examination of a similar specimen of the polymer. Fig. 2 shows the absorption spectra in the neighbourhood of 1,650 cm.$^{-1}$. The broken curve refers to the original copolymer, and shows a single sharp peak at 1,665 cm.$^{-1}$. The full curve is the spectrum of the material after treatment with acetic acid, and shows a double peak in the same region with maxima at 1,665 and 1,645 cm.$^{-1}$ respectively. The transformation $\alpha_{II} \rightarrow \beta$ has already been shown by Ambrose and Elliott[2] to be associated with a similar change in the CO stretching frequency in a number of polypeptides, the β-form giving rise to the peak at the lower frequency. A corresponding frequency shift in the NH deformation frequencies around 1,540 cm.$^{-1}$, also reported by Ambrose and Elliott, is seen in Fig. 2. If the absorption coefficients of the two forms are not very different, these results suggest that after treatment with acetic acid about one-third of the polymer is in the β-form. Since the latter does not appear in the X-ray photograph, it must be in the amorphous phase, and has probably been produced mainly from the amorphous α_{II}-phase. It would seem that acetic acid, unlike formic, only penetrates the amorphous phase of the polymer readily.

The possibility of effecting a transformation in the amorphous region of a polypeptide opens up an interesting line of attack on the contribution of this phase to the mechanical and other properties of fibres.

We are indebted to Dr. A. Elliott of these Laboratories for the infra-red absorption spectra of Fig. 2.

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Aug. 28.

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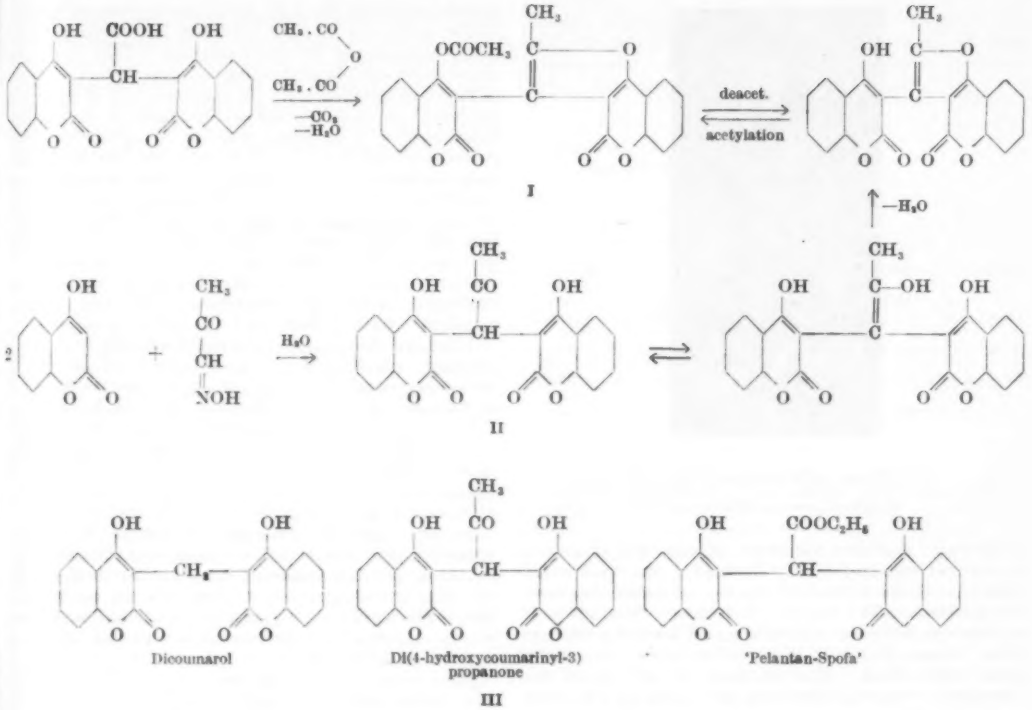
A New Powerful Blood Anticoagulant

In an effort to elucidate the mechanism of reaction of di(4-hydroxycoumarinyl-3)acetic acid, called by us 'pelentanic acid', in boiling acetanhydride[1] (I), we prepared di(4-hydroxycoumarinyl-3)propanone by condensation of two molecules of 4-hydroxycoumarin



with one molecule of *iso*nitrosoacetone in a water solution (II).

The enol-form of this new substance gives with anhydrating agents the same product as we obtained by boiling 'pelentanic acid' in acetanhydride and deacetylating the acetyl-derivative formed (II). Indeed, the two synthetic methods led to identical final products.

The structure of di(4-hydroxycoumarinyl-3)propanone is in some ways similar to that of dicoumarol, and in others to 'Pelentan-Spofa'[2].

As we expected, the new substance has a powerful anticoagulant activity in rabbits (Quick's method) like 'Pelentan-Spofa'. Its toxicity is very low, and like 'Pelentan-Spofa' it causes in oral application an earlier onset and shorter duration of hypoprothrombinæmia than dicoumarol.

A detailed study of the above reactions, and of the chemical and physiological behaviour of the new substance, will be published later. We are indebted to Mrs. Francová and Miss Holubová for the biological tests.

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July 7.

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Preparation and Biological Activity of Adrenoerythrin (? Adrenalinquinone)

In the course of experiments carried out to study the inversion mechanism of adrenalin action on the uterus, I found, in 1945 [1], that when this hormone became oxidized (auto-oxidation in water made alkaline with sodium hydroxide) a red substance occasionally appeared, which preserved intact the hypertensive action of adrenalin and, therefore, could not be the adrenochrome obtained by Green and Richter in 1936. More recently, I have again had occasion to verify the existence of this substance, which I have called 'adrenoerythrin', and a paper is now in course of publication which confirms my previous findings[2]. Previously, I have not been able to obtain this substance systematically because of the large number of factors which influence the auto-oxidation of adrenalin. The object of the present communication is to describe a method by which it is possible to obtain the substance in question regularly, and to set forth some of its properties.

I believe[1,2] that adrenoerythrin is probably the intermediate adrenalinquinone between adrenalin and adrenochrome. The existence of adrenalinquinone has been admitted as a logical step in the formation of adrenochrome; but, so far, it has not been possible to obtain it in a pure and solid form in which it could be chemically identified. Its biological properties are totally unknown, except for those which I assign to adrenoerythrin, which, in my opinion, can be identified with it. The method explained below was suggested to me, in its broad lines, by Prof. Lavollay in a recent conversation, and it is merely a variant of the technique described by McCarty for obtaining adrenochrome.

Fig. 1. Effect of 20 γ of (1) adrenoerythrine, (2) adrenaline, (3) decoloured adrenoerythrine, and (4) decoloured adrenochrome upon blood pressure of the 'spinal' cat

Method. Dissolve 250 mgm. of adrenalin in 25 ml. of normal sulphuric acid, and add 1 gm. lead oxide (PbO_2); shake while cold for two minutes and filter the mixture. The liquid which filters through is of an intense yellowish-red colour, and if left for twenty-four hours it turns brown, becoming eventually practically black. The intensity of the colour developed, compared with that produced by the same quantity of adrenochrome, is much less intense and of a yellower tone. Because of its great instability, it has not been possible to crystallize this substance.

If sodium hyposulphite in a fresh aqueous solution ($Na_2S_2O_4$) is added, the substance becomes practically wholly discoloured and the discoloured product has no green fluorescence, contrary to what occurs with adrenochrome discoloured in the same way. The yellowish-red solution obtained does not give a green colour with iron perchloride, whereas the solution discoloured with $Na_2S_2O_4$ produces a greenish colour, which seems to indicate that the adrenalin has become regenerated by the reduction. This does not occur with discoloured adrenochrome.

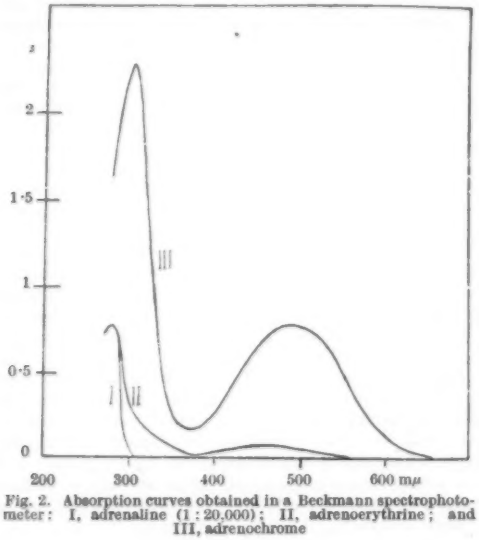

Fig. 2. Absorption curves obtained in a Beckmann spectrophotometer: I, adrenaline (1 : 20,000); II, adrenoerythrine; and III, adrenochrome

The biological activity (hypertensive) in spinal cats has also been investigated and found to be practically equal to that of the same quantity of adrenalin. This equality of action is found both in the red substance thus obtained and in the same substance after being discoloured with hydrosulphite, showing that adrenoerythrin is as active as adrenalin itself (Fig. 1). The fact that this coloured compound—which, according to our results, seems to be adrenolinquinone—preserves the whole of the biological activity of adrenalin makes me identify it with the adrenoerythrin which I described in previous papers.

I believe that this hypertensive activity of adrenoerythrin, which is of the same magnitude as that of adrenalin, invalidates the old view that oxidation of the phenol groups of adrenalin renders it inactive. I have not been able to ascertain whether the product of adrenalin oxidation thus obtained is a double quinone or a semiquinone, or whether oxidation takes place in the oxhydryl of the lateral chain, although this last suggestion is improbable.

If the classical formula of adrenochrome be accepted, it is only logical to think that the substance under review is a quinone, since the method of preparation is the same as for adrenochrome (unheated). But if Harley-Mason's views[3] are admitted, according to which adrenochrome has only a cetone group, it may be a semiquinone.

Absorption curves for adrenalin, adrenoerythrin and adrenochrome, obtained in a Beckmann spectrophotometer, are shown in Fig. 2.

A full discussion of these results will be given in a forthcoming paper[4].

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July 10.

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Nucleic Acid Content of Tumour Cells

It has been suggested[1,2] that the quantity of deoxypentosenucleic acid is constant for different somatic cells in the same species. On this assumption, the deoxypentosenucleic acid content of different tumour cells can be compared with that of normal cells from the same species. Many efforts have been made to compare the deoxypentosenucleic acid content of homologous normal and neoplastic tissues (see reviews in refs. 3 and 4). The results are rather divergent, several authors having reported an increase in deoxypentosenucleic acid in tumour cells, whereas others failed to observe any difference. We have found the Ehrlich ascites tumour of mice to be a good material for determinations of the average nucleic acid content of a single tumour cell[5,6] and have found the deoxypentosenucleic acid content of such cells to be about twice as great as that of normal mouse cells[6,7].

Recently, by the courtesy of Prof. C. Krebs (Aarhus), we were able to obtain the Krebs–Rask–

Nielsen–Wagner sarcoma[8] which also is able to grow intraperitoneally and produces a tumour-ascites, composed mainly of the typical lymphoblast-like tumour cells. We have determined the average nucleic acid content of these cells by the same methods as used previously for the Ehrlich ascites tumour. The results are shown in the accompanying table.

	Deoxypentosenucleic acid per cell (10^{-6} μgm.)	Pentosenucleic acid per cell (10^{-6} μgm.)	Pentosenucleic acid / Deoxypentosenucleic acid
Normal mouse cells (for references see ref. 6)	0·5–0·8		
Ehrlich ascites tumour (mean of 65 determinations)	1·42	2·62	1·84
Krebs sarcoma (mean of 15 determinations)	0·70	0·58	0·83
Some solid mouse tumours (ref. 3)			0·57–0·90

As is apparent from the table, the deoxypentosenucleic acid content of the Krebs sarcoma is within the range of the values for normal cells, whereas the Ehrlich carcinoma, growing under similar conditions and determined by the same methods, shows an increased value. Hence this small material of two tumours shows that different tumours may behave differently as to the average deoxypentosenucleic acid content of the cells and that this may be a factor in producing the divergencies in the literature.

Concerning the pentosenucleic acid content of the two ascites tumours, it is difficult to find a sound basis for comparison. Schneider[3] has determined the pentosenucleic acid and deoxypentosenucleic acid content in a number of different rat and mouse tumours; the ratio of the pentosenucleic acid to the deoxypentosenucleic acid calculated from his values is roughly constant for the different tumours, lying between 0·57 and 0·90. In the case of the rat liver tumour he used, Schneider has shown that there is no significant difference between the deoxypentosenucleic acid content of the tumour nuclei and that of normal liver nuclei. Assuming that the same would apply to the other solid tumours investigated by him, which show the same ratio of the two nucleic acids, a comparison of these ratios with that for the Ehrlich ascites tumour, namely, 1·84, shows that the cells of the latter contain at least four times as much pentosenucleic acid on an average as the cells of the different solid tumours investigated by Schneider. On the other hand, the Krebs sarcoma, which, as we have already seen, follows the normal cells and not the Ehrlich ascites tumour as regards its deoxypentosenucleic acid content, shows a ratio of 0·83 and is thus in the range of the solid tumours of Schneider.

Solid tumours contain cells with highly varying nucleic acid content, as has been shown by Caspersson and Santesson[9]. Comparing the ultra-violet absorption of similarly treated Ehrlich ascites tumour and solid tumours produced by the injection of the same ascites fluid, we were able to demonstrate[6] that the Ehrlich ascites tumour contains cells of uniform and comparatively high ultra-violet absorption (257 mμ) which correspond to the *A*-cells with high nucleic acid content[9] in the solid tumour. Since solid tumours consist mainly of intermediate and *B*-type cells and only a small number of *A*-cells, the high average nucleic acid content of the Ehrlich ascites tumour cells found chemically can be explained.

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June 28.

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Role of Zinc in Metabolism

Zinc is known to be a component of carbonic anhydrase[1] and is thought to be part of uricase[2]. It also is a non-specific divalent activator of several other enzymes. The striking effect of zinc deficiency on organic acid formation by fungi ('zinc shunt') has recently been reviewed[3]. Some older evidence in the literature and a generalized interpretation given for the zinc effect made it possible to predict[4] that similar effects would be obtained with deficiencies of other nutrient elements. This has been confirmed[5].

Additional evidence that zinc is a determinative factor in carbohydrate metabolism has now been accumulated for two well-known acid-producing fungi, a fumaric acid-producing strain of *Rhizopus nigricans* and a citric acid-producing strain of *Aspergillus niger*.

Washed shake mycelium was mainly used; zinc-deficient medium was obtained by Steinberg's[6] calcium carbonate method. Iron, manganese and copper were added to the purified medium. Mycelium was considered zinc-deficient only when less than half the yield of mycelium was obtained as compared to a zinc-sufficient control. Other details are precisely those described elsewhere[7,8].

Growth experiments. When equal weights of mycelial inoculum, obtained from zinc-sufficient (*ZS*) medium and from zinc-deficient (*ZD*) medium, were inoculated into *ZS* medium, the *ZS* inoculum rapidly attained maximum growth-rate (as indicated by periodic dry-weight measurements), but the *ZD* inoculum always required 10–15 hr. longer to attain maximum growth-rate. Since the ionic zinc in the test medium failed to restore the growth-rate of the *ZD* inoculum promptly, this indicated that zinc must be built up into organic combination, or that ionic zinc is necessary for the synthesis of some growth-limiting substance, and that this synthesis occurs during the observed lag period. Extracts of *ZS* mycelium, yeast extract and other natural materials, dialysed and undialysed, did not shorten the lag; this indicated that the essential substance was a large molecule and probably heat-labile. In short-time growth-experiments in Warburg respirometers, using as the criterion of growth-rate oxygen uptake with glucose as the substrate, the importance of synthesis before the lag could be eliminated was made evident by the fact that assimilable nitrogen had to be present

to restore *ZD* mycelium; ionic zinc and the other nutrient elements were ineffectual. Also, oxygen was essential; the effect was absent anaerobically in the presence of assimilable nitrogen.

Respiration experiments. The endogenous respiration (Q_{O_2}) of zinc-deficient mycelium was slightly less than that of zinc-sufficient mycelium, and exogenous respiration of several substrates (glucose, ethanol, acetate and malate) was slightly higher in *ZD* mycelium. Oxidative assimilation of glucose was no different in *ZS* and in *ZD* mycelium.

Fermentation experiments. In contrast to the dubious significance of the aerobic respiration differences between zinc-sufficient and zinc-deficient mycelium on glucose there were striking differences in anaerobic respiration (fermentation), as displayed by carbon dioxide evolution measured manometrically (Table 1).

TABLE 1

Experiment	Zinc-deficient mycelium		Zinc-sufficient mycelium	
	Q_{CO_2}	$Q_{CO_2}^{glucose}$	Q_{CO_2}	$Q_{CO_2}^{glucose}$
(1) *R. nigricans*	0	9·8	2·8	73·5
(2) "	0	9·6	0	62·6
(3) *A. niger* "	0	1·0	1·5	10·0

Pyruvic carboxylase experiments. The fermentation effect was traced to pyruvic carboxylase in *Rhizopus nigricans*, though other enzymes cannot be excluded. Tests with *Aspergillus* are in the early stages. Desiccated *R. nigricans* mycelium is more permeable to pyruvic acid than living mycelium. Zinc-deficient and zinc-sufficient mycelium dried overnight *in vacuo* over phosphorus pentoxide were tested for pyruvate carboxylase activity as judged by carbon dioxide evolution from pyruvic acid at *p*H 6·3 in the absence of oxygen. In numerous trials, *ZD* mycelium never evolved carbon dioxide at more than a negligible rate, whereas *ZS* mycelium evolved large amounts. Acetaldehyde was identified as the other product of the decarboxylation by preparation of the 2,4-dinitrophenylhydrazone from the neutral volatile fraction. Cell-free juices obtained by grinding air-dried living mycelium with sand with a mortar and pestle behaved similarly: juices from *ZD* mycelium always had negligible pyruvic carboxylase activity whereas its *ZS* counterpart displayed $Q_{CO_2}^{pyruvate}$ values ranging from 200 to 1,800 depending on the method of preparation. Ionic zinc, cocarboxylase and magnesium ions added to the deficient juice did not elicit any pyruvate carboxylase activity.

Zinc content of pyruvic carboxylase preparations. It seemed probable that pyruvic carboxylase was the substance the synthesis of which accounted for the lag in the growth experiments described above. Also, a question arose as to whether pyruvic carboxylase of *R. nigricans* is a zinc protein, a point all the more interesting because carbonic anhydrase also is a carbon dioxide-liberating enzyme. Experiments with potassium cyanide and sodium azide as poisons for pyruvic carboxylase preparations, carried out in a manner similar to the poisoning experiments of Keilin and Mann[1] with carbonic anhydrase, did not lead to reduction in activity of the enzyme, suggesting that the enzyme may not be a zinc protein. Ammonium sulphate fractionation of dialysed mycelial juice was performed to obtain preparations of different stages of purity of the enzyme; the zinc contents were determined by the growth response of *Rhizopus nigricans* to ashed samples in a virtually zinc-free basal medium. A straight-line response to increments of a standard zinc solution was obtained, and the responses of the unknown preparations were compared with the standard curve. Each preparation was dialysed before testing for activity. While the results (Table 2) are not wholly satisfactory, it may be seen (Exp. 1 and 2) that the zinc content of the purified preparations either remained the same as the unpurified (dialysed) starting juice, or was much less (Exp. 3). In either case, the content would be expected to rise with increased potency of the preparations. The best gauge of the actual relations is the ratio per cent Zn/Q_{CO_2} in Table 2. This expresses the zinc content with respect to enzyme activity, and in each experiment the results are clearly in the opposite direction to what one would expect if the enzyme were indeed a zinc protein. However, it must be emphasized that probably the best enzyme preparation obtained still is far from pure. Also it is clear that substantial amounts of inert organic zinc substances are present in the crude mycelium juice.

TABLE 2

Experiment	Fraction precipitated by ammonium sulphate	Q_{CO_2}	% Zinc	$\frac{\% \text{ Zn}}{Q_{CO_2}} \times 10^6$
1	Starting juice	710	0·064	9·0
	40 per cent	1,636	0·074	4·5
	40 " *	1,891	0·057	3·0
2	Starting juice	1,772	0·064	3·6
	20 per cent	0	0·031	—
	30 "	0	0·045	—
	40 "	4,163	0·062	1·5
	50 "	0	0·020	—
3	Starting juice	930	0·054	5·8
	20 per cent	0	0·031	—
	40 "	1,855	0·012	0·64

* This fraction was obtained by dissolving the precipitate obtained with 40 per cent saturation with ammonium sulphate, dialysing and reprecipitation at 40 per cent ammonium sulphate saturation.

We may conclude that zinc is essential for the synthesis of pyruvic carboxylase in *R. nigricans* even though, at present, indications are that the metal is not part of the enzyme. It is possible that under conditions of zinc deficiency an inhibitor is formed.

The foregoing results implement the previous mass of experimental evidence, and the interpretation that zinc plays a specific part in the utilization of carbohydrate by fungi.

This work was supported by grants from Ciba Pharmaceutical Laboratories, Inc., and Merck and Co., Inc., and by a grant-in-aid from the American Cancer Society upon recommendation of the National Research Council Committee on Growth.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 13

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. O. H. K. Spate: "The Geography of Determinism".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Discussion on "Cybernetics" (to be opened by Mr. D. M. MacKay).

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Clayton Memorial Lecture.*

INSTITUTION OF THE RUBBER INDUSTRY, MIDLANDS SECTION (in the Pavilion, Goodyear Park, Wolverhampton), at 7 p.m.—Mr. D. E. Jones: "What the Factory Inspector requires of the Rubber Industry".

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the Chelsea Polytechnic Chemical Society, at Chelsea Polytechnic, Manresa Road, London, S.W.3), at 7 p.m.—Dr. J. H. Schulman: "The Physical Chemistry of Hæmolysis".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at the Royal Institution, 21 Albemarle Street, London, W.1), at 7 p.m.—Prof. A. Haddow: "The Chemotherapy of Cancer".

INSTITUTION OF WORKS MANAGERS, SHEFFIELD BRANCH (joint meeting with the INSTITUTION OF PRODUCTION ENGINEERS, at the Grand Hotel, Sheffield), at 7.30 p.m.—"Mechanical Handling".

Monday, November 13—Saturday, November 18

PUBLIC WORKS AND MUNICIPAL SERVICES (at The Olympia, Hammersmith Road, London, W.14).—Congress and Exhibition.

Tuesday, November 14

CHADWICK PUBLIC LECTURE (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. W. Shaw: "Incidents in the Life of a Sanitary Inspector".*

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 4.30 p.m.—Mr. C. G. A. Rosen: "Significant Contributions of the Diesel Research Laboratory" (James Clayton Lecture).

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. Dorothy Hodgkin, F.R.S.: "Crystallography in Modern Science, (iii) Crystallography in Biology".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Prof. A. L. L. Baker: "Recent Research in Reinforced Concrete and its Application to Design".

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting of the MEASUREMENTS AND RADIO SECTIONS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. M. Smith: "The Determination of Time and Frequency"; Dr. L. Essen: "Frequency Standardization".

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. C. Dykes Brown: "The Lighting of the New House of Commons".

INCORPORATED PLANT ENGINEERS, EAST LANCASHIRE BRANCH (at the Engineers' Club, Albert Square, Manchester), at 7.15 p.m.—Mr. H. L. Gloag: "The Application of Colour in Industry".

CHEMICAL SOCIETY, NORTHERN IRELAND SECTION (joint meeting with the ANDREWS CLUB, the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in Chemistry Lecture Theatre, Queen's University, Belfast), at 7.30 p.m.—Prof. E. L. Hirst, F.R.S.: "Some Problems in the Chemistry of the Polysaccharides".

INSTITUTION OF WORKS MANAGERS, WEST YORKSHIRE BRANCH (at the George Hotel, Huddersfield), at 7.30 p.m.—Mr. A. P. Young: "Industrial Management and its Human and Social Implications".

Wednesday, November 15—Thursday, November 16

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Conference on "Electricity as an Aid to Productivity".

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1).—Autumn General Meeting.

Thursday, November 16

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. E. Ashworth Underwood: "Anatomy and the Graphic Arts".*

UNIVERSITY OF LONDON (at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5), at 3 p.m.—Prof. J. Z. Young, F.R.S.: "Cortical Structure and Function".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—"The Structure of Synthetic Polypeptides". Dr. C. H. Bamford, Mr. W. E. Hanby and Dr. F. Happey: "X-Ray Investigation"; Mr. E. J. Ambrose and Dr. A. Elliott: "Infra-Red Investigation".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. E. C. Ellwood: "Treatment of Gold Ores in South Africa and Canada"; Dr. J. R. F. Joyce: "Note on an Apparatus for the Experimental Investigation of Hydrothermal Replacement and Ore Deposition".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. J. Dieudonné: "The Classical Groups".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5.30 p.m.—"The Seasons" (Sound films with introduction by Miss M. C. Simpson and Mr. G. J. Cons).

UNIVERSITY OF LONDON (in the Senate House, London, W.C.1), at 5.30 p.m.—Prof. F. A. E. Crew, F.R.S.: "The Biological Aspects of War".* (Further Lectures on November 23 and 30.)

CHEMICAL SOCIETY, HULL SECTION (joint meeting with UNIVERSITY COLLEGE SCIENTIFIC SOCIETY, in the Science Lecture Theatre, University College, Hull), at 6 p.m.—Sir John Lennard-Jones, F.R.S.: "Recent Theories of Molecular Structure".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8.15 p.m.—Prof. J. E. Roberts: "Problems and Possibilities in the use of Co60 for Radiotherapy".

Thursday, November 16—Friday, November 17

INSTITUTE OF PHYSICS, X-RAY ANALYSIS GROUP (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1).—Conference on "The Development and Application of Fourier Methods in Crystal Structure Analysis".

Thursday, November 16—Sunday, November 19

BRITISH INSTITUTE OF MANAGEMENT, in association with the INSTITUTE OF INDUSTRIAL ADMINISTRATION (at Harrogate).—Management Conference.

Friday, November 17

BIOCHEMICAL SOCIETY (in the Lecture Theatre, Wright-Fleming Institute, St. Mary's Hospital Medical School, Paddington, London, W.2), at 2 p.m.—Scientific Papers.

CHEMICAL SOCIETY, SOUTHAMPTON SECTION (joint meeting with UNIVERSITY COLLEGE CHEMICAL SOCIETY, in the Physics Department, University College, Southampton), at 5 p.m.—Sir Cyril Hinshelwood, F.R.S.: "Kinetics of the Bacterial Cell".

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Lieut.-Comdr. J. D. Moore and Comdr. A. V. Thomas: "Surface Navigation in High Latitudes".

CHEMICAL SOCIETY, SOUTH WALES SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and UNIVERSITY COLLEGE CHEMICAL SOCIETY, at University College, Swansea), at 5.30 p.m.—Prof. C. W. Davies: "Ion Exchange Resins".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Sir Harry Ricardo, F.R.S.: "Supercharging of Internal Combustion Engines" (Thomas Hawksley Lecture).

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. John R. Shearer: "A Preliminary Investigation of the Discrepancies between the Calculated and Measured Wave-making of Hull Forms".

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 6.30 p.m.—Dr. C. W. Gilbert: "Some Aspects of the Production of Radioactive Isotopes".

INSTITUTE OF INDUSTRIAL ADMINISTRATION, MANCHESTER CENTRE (joint meeting with the NORTH-WEST REGION of the INSTITUTE OF ECONOMIC ENGINEERING, in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. J. A. Scott: "Industrial Efficiency—Management's Problem".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. E. C. Bullard, F.R.S.: "The Earth's Magnetic Field".

CHEMICAL SOCIETY, GLASGOW SECTION (in the Chemistry Department, The University, Glasgow), at 7.15 p.m.—Prof. R. M. Barrer: "Some Problems in Gas Flow and Sorption".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. Ralph Cory: "Fifty Years at the Royal Institution".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT CHEMIST in the Research Department at Crewe—The Superintendent (Chemistry Division), Research Department, Railway Executive, London Road, Derby (November 18).

LECTURER IN THE DEPARTMENT OF CHEMISTRY AND BIOLOGY, City College of Technology—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (November 18).

RESEARCH ASSISTANT IN THE DEPARTMENT OF HÆMATOLOGY, as a member of a team concerned with the investigation of hæmoglobin metabolism—The House Governor, King's College Hospital, Denmark Hill, London, S.E.5 (November 18).

ASSISTANT LECTURERS (2) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING (electro-technics)—The Registrar, The University, Liverpool (November 20).

LECTURER IN PHYSIOLOGY—The Registrar, King's College, Strand, London, W.C.2 (November 25).

PHYSICISTS and ELECTRICAL ENGINEERS at a Ministry of Supply Research and Development Establishment in the South Midlands: PRINCIPAL SCIENTIFIC OFFICERS (*a*) to lead a team in electronics research with special reference to microwave techniques, (*b*) to lead a team engaged on development of fire control radar equipment; SCIENTIFIC OFFICERS for research and development work on Army radar equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.296/50A (November 25).

TECHNICAL OFFICER (woman, with a degree in chemistry and administrative and industrial experience) in the Technical and Scientific Register.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.380/50A (November 25).

ELECTRONIC ENGINEERS and PHYSICISTS (Experimental Officer grade) at Ministry of Supply Research and Development Establishments in and near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.294/50A (November 27).

EXPERIMENTAL OFFICER IN THE MECHANICAL ENGINEERING RESEARCH ORGANISATION (Department of Scientific and Industrial Research), for work on the effect of high pressure on the properties of materials—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.587/50A (November 27).

HONOURS GRADUATE IN ZOOLOGY, for whole-time research on various diseases of the adult honey-bee—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (November 28).

ASSISTANT KEEPER IN ARCHÆOLOGY AND ETHNOLOGY in the Museums Department—The Town Clerk, Municipal Buildings, Liverpool 2 (November 30).

LECTURER IN GENETICS, and a LECTURER IN MATHEMATICS, at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

PROFESSOR OF GEOLOGY—The Dean, Faculty of Science, Fouad I University, Abbassia, Cairo, Egypt (November 30).

RESEARCH OFFICERS or TECHNICAL OFFICERS FOR COAL UTILIZATION RESEARCH, Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organisation—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3025 (November 30).

SENIOR RESEARCH OFFICER, Grade I, at the Ministry of Agriculture's Veterinary Laboratory, Weybridge—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 3336 (November 30).

SENIOR LECTURER IN PHYSICAL CHEMISTRY at the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 8).

CHAIR OF PHILOSOPHY at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 11).

ASSISTANT KEEPER IN BOTANY in the Manchester Museum—The Registrar, The University, Manchester 13 (December 15).

CHAIR OF CHINESE ART AND ARCHÆOLOGY at the School of Oriental and African Studies—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 15).

SENIOR LECTURER IN MECHANICAL ENGINEERING at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 15).

SENIOR LECTURER or LECTURER IN PHYSICS, and a SENIOR LECTURER or LECTURER IN PHILOSOPHY, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 16).

LECTURER IN BOTANY, a SENIOR LECTURER IN AGRICULTURAL CHEMISTRY, a SENIOR LECTURER or LECTURER IN ECONOMICS, and a SENIOR LECTURER IN STATISTICAL METHODS, at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 31).

CHAIR OF PURE MATHEMATICS—The Secretary, The University, Birmingham 3 (January 1).

CHAIR OF APPLIED MATHEMATICS—The Secretary, Queen's University, Belfast (January 15).

DIRECTOR OF THE MARINE BIOLOGICAL STATION being established at Bangor to develop the facilities for the study of marine biology within the University of Wales—The Secretary and Registrar, University College of North Wales, Bangor (January 31).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Education in 1949: being the Report of the Ministry of Education and the Statistics of Public Education for England and Wales. (Cmd. 7957.) Pp. ix+236+8 plates. (London: H.M. Stationery Office, 1950.) 5*s.* 6*d.* net. [168

Colonial Development and Welfare Acts. Returns of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies, with the concurrence of the Treasury, in the Period from 1st April, 1949, to 31st March, 1950. Pp. 73. (London: H.M. Stationery Office, 1950.) 1*s.* 9*d.* net. [168

Colonial Office. The British Territories in East and Central Africa, 1945–1950. (Cmd. 7987.) Pp. iv+166. (London: H.M. Stationery Office, 1950.) 4*s.* net. [168

British Journal of Radiology. Supplement No. 2: Some Applications of Nuclear Physics to Medicine. By Prof. W. V. Mayneord. Pp. xii+290. (London: British Institute of Radiology, 1950.) 35*s.* [178

Recommendations for the Design and Fabrication of Arc Welded Structural Steelwork, Built-up Girders and Compression Members. Pp. 12. (London: British Welding Research Association, 1950.) 1*s.* 6*d.* [178

City of Gloucester Folk Museum. Guide to the Collection of Bygone Agricultural Implements. By J. Neufville Taylor. Pp. 20+4 plates. (Gloucester: Folk Museum, 1950.) 9*d.* [178

Creative Love. By George T. Hill. (Fourth Annual Lecture delivered in Birmingham, Glasgow and London, 1948–49.) Pp. iii+22. (Woodford Green: New Church College, 1950.) 1*s.* 6*d.* net. [178

A Description of the International Council of Scientific Unions. Pp. vi+137. (Cambridge: International Council of Scientific Unions, Caius College, 1950.) [178

East Malling Research Station. Annual Report, 1st January, 1949, to 30th September, 1949. Pp. 187+21 plates. (East Malling: East Malling Research Station, 1950.) 10*s.* [178

Eighty-sixth Annual Report on Alkali, &c. Works, covering the Year 1949. By the Chief Inspector. Pp. 40. (London: H.M. Stationery Office, 1950.) 1*s.* net. [178

Other Countries

Carnegie Institution of Washington. Publication 589: Maya Hieroglyphic Writing; Introduction. By J. Eric S. Thompson. Pp. xvii+337+64 plates. (Washington, D.C.: Carnegie Institution, 1950.) 7 dollars. [148

Transactions of the American Philosophical Society. New Series, Vol. 39, Part 3: The Pottery of Marajó Island, Brazil. By Helen C. Palmatary. Pp. 259–470 (112 plates). (Philadelphia: American Philosophical Society, 1950.) 3 dollars. [148

What Israel Thinks. (Quarterly.) Vol. 1, No. 1, Summer. Pp. 8. (Jerusalem: Israel Institution of Applied Social Research, 1950.) Annual subscription, 2 dollars. [148

Adrenal Cortex. Transaction of the First Conference, November 21–22, 1949. Edited by Elaine P. Ralli. Pp. 189. (New York: Josiah Macy Jr. Foundation, 1950.) 2 dollars. [148

British Guiana. Report on the Geological Survey Department for the Year 1949. Pp. iii+40. (Georgetown: Geological Survey Department, 1950.) 1 dollar; 4*s.* 2*d.* [158

South African Council for Scientific and Industrial Research. Fourth Annual Report, 1948–1949. Pp. 84+7 plates. (Pretoria: South African Council for Scientific and Industrial Research, 1950.) [158

Indian Association for the Cultivation of Science. Special Publication No. 14: Distribution of Anthocyanins. By Sir Robert Robinson. Pp. 16. 1.4 rupees; 2*s.* Annual Report for 1949–50. Pp. ii+49. (Calcutta: Indian Association for the Advancement of Science, 1950.) [158

'Juan de la Cierva' Foundation for Technical Research: its Organization and Development. Pp. 40. (Madrid: 'Juan de la Cierva' Foundation, 1950.) [178

Canada: Department of Mines and Technical Surveys, Geological Survey. Bulletin No. 15: Actinocamax from the Upper Cretaceous of Manitoba, by J. A. Jeletsky; Sciophyllum, a New Rugose Coral from the Canadian Arctic, by P. Harker and D. J. McLaren. Pp. v+43 (4 plates). 25 cents. Memoir 255: Callum Creek, Langford Creek, and Gap Map-areas, Alberta. By R. J. W. Douglas. (No. 2493.) Pp. vii+124. 1 dollar. (Ottawa: King's Printer, 1950.) [178

Canada: Department of Mines and Technical Surveys, National Museum of Canada. Bulletin No. 116 (Anthropological Series No. 28): Folk-Lore of Waterloo County, Ontario. By W. J. Wintemberg. Pp. vii+68. 50 cents. Bulletin No. 117 (Anthropological Series No. 29): Folklore of Lunenburg County, Nova Scotia. By Helen Creighton. Pp. v+163. 50 cents. Bulletin No. 118: Annual Report of the National Museum for the Fiscal Year 1948–1949. Pp. v+120 (23 plates). 25 cents. (Ottawa: King's Printer, 1950.) [178

Chicago Natural History Museum. Report of the Director to the Board of Trustees for the Year 1949. Pp. 140. (Chicago: Chicago Natural History Museum, 1950.) 1 dollar. [178

Ministry of Public Works, Egypt: Physical Department. Paper No. 46: The Nile Basin. By Dr. H. E. Hurst and R. P. Black. Third Supplement to Vol. 2: Measured Discharges of the Nile and its Tributaries in the Period 1938–1942. Pp. viii+216. (Cairo: Government Press, 1949.) PT. 100; 20*s.* [178

Thomas Baker, Alice Baker and Eleanor Shaw Medical Research Institute. Collected Papers, Vol. 5, 1946–1949. 27 Papers. (Melbourne: Alfred Hospital, 1950.) [178

Western Australia. Report of the Director of Government Chemical Laboratories for the Year 1947. Pp. 28. (Perth: Government Printer, 1950.) [178

United States Department of the Interior: Geological Survey. Bulletin 948-E: Preliminary Report on Corundum Deposits in the Buck Creek Peridotite Clay County, North Carolina. By Jarvis B. Hadley. (Strategic Minerals Investigations, 1945.) Pp. iv+103–128. 60 cents. Bulletin 955-C: Phosphate Deposits of the Deer Creek–Wells Canyon Area, Caribou County, Idaho. By Charles Diess. (Contributions to Economic Geology, 1947.) Pp. iv+61–101. 45 cents. Bulletin 966-D: Geophysical Abstracts 139, October–December 1949 (Numbers 11442–11678). By Mary C. Rabbitt, V. L. Slitsky and S. T. Vesselowsky. Pp. iii+253–333. 25 cents. Bulletin 968: Bibliography of North American Geology, 1948. By Emma Mertins Thom, Marjorie Hooker and Ruth Reece Dunaven. Pp. iii+309. 60 cents. (Washington, D.C.: Government Printing Office, 1949–1950.) [178

Meddelande från Lunds Astronomiska Observatorium. Ser. 1, Nr. 170: A Study of the Absorption in NGC 5195. By Erik Holmberg. Pp. 12. Ser. 2, Nr. 127: On Quadrature Formulæ. By Anders Reiz. Pp. 8. Ser. 2, Nr. 128: A Photometric Study of nearby Galaxies. By Erik Holmberg. Pp. 56. (Lund: Astronomiska Observatorium, 1950.) [218

Unesco: Middle-East Science Co-operation Office. List of Scientific Papers published in the Middle-East received by this Office between 1st October 1949 and 1st March 1950. No. 5, June. Pp. 78. (Cairo: Unesco Middle-East Science Co-operation Office, 1950.) [218

Publications of the Dominion Observatory, Ottawa. Vol. 14: Bibliography of Seismology. No. 6: Items 7132–7221, July to December 1949. By W. G. Milne. Pp. 135–146. (Ottawa: King's Printer, 1950.) 25 cents. [218

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 37: Regenval in Indonesië (Rainfall in Indonesia). Door Prof. Dr. H. P. Berlage, Jr. Pp. 212. (Batavia: Koninklijk Magnetisch en Meteorologisch Observatorium, 1949.) [218

Catalogues

Siemens Engineering Bulletin. No. 252, May: The Type 1200 High-speed Motor Uniselector. Pp. 8. (London: Siemens Brothers and Co., Ltd., 1950.)

The Lamp. Vol. 32, No. 2. Pp. 24. (New York: Standard Oil Co., 1950.)

Induction Heating Equipment. Pp. 16. (Watford: Wild-Barfield Electric Furnaces, Ltd., 1950.)